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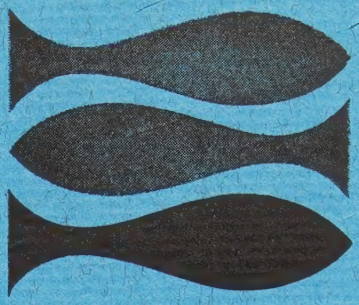


INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION

ANNUAL REPORT 1961

VANCOUVER, CANADA, 1963

INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION

OFFICERS FOR 1961

Chairman ..... **Iwao Fujita**
Vice-Chairman ..... **Edward W. Allen**
Secretary ..... **George R. Clark**

MEMBERS—1961

CANADA

George R. Clark
John M. Buchanan
James C. Cameron
Roger T. Hager

UNITED STATES

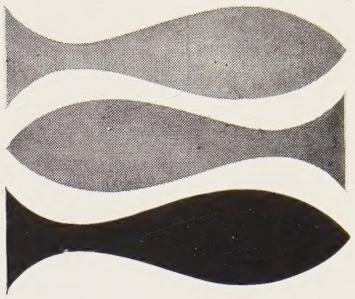
Milton E. Brooding
Edward W. Allen
John H. Clawson
Arnie J. Suomela (to June 24, 1961)
Clarence F. Pautzke (from June 24, 1961)

JAPAN

Iwao Fujita
Yoshimitsu Ando
Kenjiro Nishimura (to September 8, 1961)
Masayoshi Ito (from September 8, 1961)
Kenkichi Nakabe (to September 8, 1961)
Koichiro Kobayashi (from September 8, 1961)

SECRETARIAT

Roy I. Jackson, Executive Director
Hiroshi Kasahara, Assistant Director



INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION

Established by Convention between Canada, Japan and the United States for the Conservation of the Fisheries Resources of the North Pacific Ocean

ANNUAL REPORT 1961

OFFICES: 6640 Northwest Marine Drive
Vancouver 8, B.C., Canada

LETTER OF TRANSMITTAL

The Chairman of the International North Pacific Fisheries Commission presents his compliments to the Contracting Parties and their Commissioners and has the honour to transmit herewith an annual report describing the activities of the Commission during the year terminating with the adjournment of the Eighth Annual Meeting on November 11, 1961.

This is the eighth consecutive annual report summarizing the activities and achievements of the Commission. The report contains a summary account of the Eighth Annual Meeting and a brief resume of the activities of the Commission's Secretariat. In addition, the report contains summaries of the results of research prepared by the national research agencies which carry out the scientific investigations which have been programmed and coordinated by the Commission. The views expressed in the summaries are those of the authors and not necessarily those of the Commission. Accuracy of translation is the responsibility of the Secretariat.

The report is presented in compliance with Article III (1) (f) of the International Convention for the High Seas Fisheries of the North Pacific Ocean and Rule 14 (f) of the Rules of Procedure.

Iwao Fujita,
Chairman.

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I. REPORT OF THE EIGHTH ANNUAL MEETING

of the

INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION

Tokyo, Japan, November 6 to 11, 1962

1. Introduction

On June 12, 1953, exchange of ratifications between Canada, Japan and the United States brought into force the International Convention for the High Seas Fisheries of the North Pacific Ocean. The purpose of the Convention is to ensure the maximum sustained productivity of the fisheries resources of the Convention area. The Convention provided for the establishment of the International North Pacific Fisheries Commission to promote and coordinate the necessary scientific studies and to recommend the required conservation measures in order to secure the maximum sustained productivity of fisheries of joint interest. The Commission, consisting of four members from each of the member countries, herewith presents the report of its Eighth Annual Meeting.

2. Time and Place of Meeting

The Eighth Annual Meeting of the International North Pacific Fisheries Commission was held at the Ministry of Foreign Affairs, Tokyo, Japan, from November 6 to 11, 1961, under the chairmanship of Commissioner Iwao Fujita of Japan.

The plenary sessions were preceded by preliminary meetings of various committees which dealt with matters assigned to them on a continuing basis. Committee meetings were also held at frequent intervals during the week in which the plenary sessions were held.

The Committee on Biology and Research began its sessions at the Ministry of Foreign Affairs in Tokyo on October 23. The chairman of the Committee was Commissioner James C. Cameron of Canada. Dr. Hiroaki Aikawa of Japan was chosen as the Convenor of the scientific sessions. However, Dr. Aikawa's illness necessitated that his place as convenor be taken by Mr. Yoshikazu Yamanaka of Japan. The Committee on Biology and Research and its numerous sub-committees met on an almost daily basis throughout the period of the annual meeting.

The Scientific Sub-Committee of the Ad Hoc Committee on Abstention met on November 2 and 3. Its parent committee began its sessions on November 3 under the chairmanship of Commissioner George R. Clark of Canada. The Ad Hoc Committee on the Protocol, of which Mr. Clark was also chairman, held its first session on November 7. The Standing Committee on Finance and Administration began its work on November 6 under the chairmanship of Commissioner Clarence F. Pautzke of the United States.

3. Participants

Each national section of the Commission was represented by its full complement of four Commissioners at the meeting. As usual, the national sections were accompanied and assisted by advisors, experts and, in the case of the United States delegation, members of its Advisory Committee. Observers, present at the invitation of the Commission, represented the International Pacific Halibut Commission, the International Pacific Salmon Fisheries Commission, the International Commission for the Northwest Atlantic Fisheries, the Inter-American Tropical Tuna Commission and the Union of Soviet Socialist Republics. The total number of accredited participants for the meeting was 131*, including 13 representatives from Canada, 58 from Japan, 37 from the United States, eight observers and three permanent and 17 temporary members of the Secretariat.

Lists of the officers and members of the Commission and its various committees and the names of all accredited participants in the Eighth Annual Meeting are given in Appendix I of this report.

4. The Agenda

The Commission adopted, without change, the provisional agenda for the Eighth Annual Meeting which had been circulated sixty days in advance of the meeting. In adopting the agenda, two understandings were agreed to by the Commission: first, that items on the agenda might be considered in a different sequence; secondly, approval was given to a Canadian

* Five national delegation members also acted as observers for invited international organizations.

proposal that under Agenda Item 15—" Other business "—the Commission could discuss the subject of the effect of trawling operations on the halibut stocks in the Convention area. The agenda may be found in Appendix II of this report.

5. The Opening Session

The first plenary session of the Eighth Annual Meeting, which was open to the public, was held in the Auditorium of the Ministry of Foreign Affairs on Monday, November 6, 1961. Chairman Iwao Fujita presided at the meeting. The Honourable Ichiro Kono, Minister of Agriculture and Forestry for Japan, addressed the opening plenary session. The Minister, on behalf of the Government of Japan, welcomed the delegations from abroad and congratulated the Commission on its research findings. The Minister spoke of Japan's dependence on fish in the national diet and the significant role played by fisheries products in Japan's export trade. He referred to Japan's active support of international measures for fisheries conservation and maximum utilization and foresaw expansion of efforts in this direction in the future. The Minister stated that in the future, when the North Pacific Convention itself is to be discussed, the Government of Japan would present its case fully, give due regard to the views of others and proceed, on the basis of mutual understanding and trust, toward conservation and utilization of the fisheries resources of the North Pacific in a way most reasonable and appropriate to the countries concerned.

The Honourable Stewart L. Udall, Secretary of the Interior for the United States, and a special representative on the United States delegation, addressed the opening plenary session. After expressing his appreciation of the hospitality extended by the people of Japan, the Secretary referred to the value of the fisheries resources in meeting the increasing world demand for food and the obligation to plan for the welfare of future generations as well as for the present. Mr. Udall commended the Commission on the progress it had made, particularly in the field of research. Pointing out that research is a means to an end, not an end in itself, he referred to the intermingling of salmon from the two continents in mid-ocean and the problems this poses for protection of the Bristol Bay sockeye salmon stocks, which have become subject to a Japanese fishery. The problem will be especially critical in 1962 because of the expected small size of the sockeye salmon runs to Bristol Bay. Restraint was needed. The matter was of prime concern to the Government of the United States.

In addition, the Secretary called attention to a new problem which would arise if bottom fishing operations were expanded to the waters of the eastern North Pacific Ocean, thus jeopardizing conservation of the halibut resources. These resources, utilized by Canada and the United States, are under abstention by Japan. The Secretary believed it appropriate that the Commission should take cognizance of this problem, recognize the need for restraint and make appropriate recommendations to the governments.

Commissioner George R. Clark, Chairman of the Canadian National Section, addressed the opening plenary session on behalf of the Canadian delegation. Mr. Clark expressed the pleasure of his delegation at again enjoying the opportunity to visit Japan. He expressed regret at the illness of Dr. Hiroaki Aikawa, the senior scientist of the Japanese National Section, and hoped that he would soon return to good health. Mr. Clark referred to progress in the Commission's research program and believed that it had achieved a large measure of success. In relation to the continued qualification for certain stocks of fish under abstention, the Canadian Section contended that the stocks of fish for which Canada has submitted reports continued to meet the conditions for abstention. Canadian fishermen were often severely restricted for conservation purposes and efforts by the Canadian government to maintain and improve fisheries resources, on a scientific basis, were continuing. The Canadian Section believed that the scope of the Commission's research program on salmon should be enlarged. Further views on the subject would be presented and it was hoped the Commission would take definite action.

Commissioner Milton E. Brooding, Chairman of the United States National Section, addressed the opening plenary session on behalf of the members of his delegation. He described the pleasure of his group at again meeting their colleagues from Canada and Japan. In referring to the problems facing the Commission which Mr. Udall, the Secretary of the Interior, had described, Mr. Brooding stressed the value of candor, free exchange of information and a determination to find practical solutions as essentials in dealing with the questions. Increased effort was required to solve the important problems facing the Commission.

Commissioner Koichiro Kobayashi addressed the opening plenary session on behalf of the Japanese National Section. He welcomed his colleagues from abroad to Japan and greeted the observers from other international fisheries organizations and governments. Mr. Kobayashi spoke of the value of the fisheries re-

sources of the North Pacific Ocean and referred to the severe obligation placed on Japan under the abstention provisions of the Convention. However, he stated, Japan did not intend to ask for an unrealistic level of qualification by the non-abstaining nations. Mr. Kobayashi pointed out that in recent years there had been new developments, not foreseen at the time of the negotiation of the present Convention, which had increased the importance of the work of this Commission. The Japanese Section believed that ensuring of maximum sustained productivity of the fishery resources of the North Pacific Ocean was the goal of the Convention. However, the need for utilizing these resources to the maximum possible extent, with proper regard to reproductive requirements, should not be forgotten.

The Chairman of the Commission, Mr. Iwao Fujita of Japan, gave the final address at the opening plenary session. The Chairman welcomed the delegates, observers and guests and greeted new members of the Commission. He gave a brief review of the duties and accomplishments of the Commission and described the questions which the Commission now faces as extremely complex and difficult. Nevertheless, the Chairman believed that, with frankness and mutual understanding, further progress would be made toward the accomplishment of the objectives of the Convention and friendly relations between the three countries would thereby be strengthened.

6. Procedures for the Meeting

The Commission continued to follow its established policy with respect to attendance at meetings. This policy provides that the first plenary session of each annual meeting is open to the public and that other plenary sessions of the Commission and meetings of its standing committees are open to guests and observers who have been invited by the Commission, except meetings which may be held *in camera*.

Commissioners George R. Clark of Canada, Yoshimitsu Ando of Japan and Edward W. Allen of the United States were named to a press committee to work with the Chairman of the Commission and the Secretariat in preparing and disseminating information for the press.

The Commission made no change in its established procedure for handling of minutes of plenary sessions. This practice has been described in past annual reports.

7. Consideration of Administrative Matters

7 (a) Report of the Chairman

The address of the Chairman of the Commission, Mr. Iwao Fujita of Japan, as given at the opening plenary session, was adopted by the Commission as the Chairman's Report for 1961.

7 (b) Submission of Reports by the Secretariat

The Executive Director submitted the following reports to the Commission on behalf of the Secretariat:

i. Auditors' Report for the fiscal year ended June 30, 1961 (INPFC Doc. 459).

ii. Budget estimate for 1962–63 and budget forecast for 1963–64 (INPFC Doc. 462).

iii. Administrative Report for 1961 (INPFC Doc. 463).

iv. Comments on the form and nature of the reports submitted by Canada and the United States in 1961 under Articles III (1) (c) (iii) and X (2) of the Convention (INPFC Doc. 464).

v. Statistical Yearbook for 1960.

These reports were referred to the appropriate standing committees for information, review and report. Final disposition of the reports by the Commission is recorded in the sections of this report dealing with the work of the standing committees.

7 (c) Report of the Standing Committee on Finance and Administration

Matters relating to finance and administration are assigned by the Commission to its Standing Committee on Finance and Administration for consideration and recommendations. The Committee, under the chairmanship of Commissioner Clarence F. Pautzke, and with members as listed in Appendix I of this report, made a number of recommendations to the Commission, all of which were adopted at the final plenary session. The recommendations as adopted are summarized below:

i. The Committee approved the Commission's accounts and the report of the auditors, Peat, Marwick, Mitchell & Co., for the fiscal year ending June 30, 1961, and recommended approval by the Commission. Expenditures for operation of the Commission's Secretariat totalled $48,792.59 (Canadian funds) for the period. The auditors' report appears as an appendix to Part II of this annual report. The Committee also recommended that the Secretariat be instructed to continue to provide statements of explanation of items in the auditors' report and the relationships between items.

ii. The Committee recommended that the Commission adopt a budget totalling $71,409 (Canadian funds)

for the operation of its headquarters for the fiscal year beginning July 1, 1962. Each Contracting Party contributes one-third of the funds required for the operation of the Secretariat.

iii. The Committee presented to the Commission a budget forecast totalling $78,642 (Canadian funds) for the operation of its headquarters for the fiscal year beginning July 1, 1963. This budget forecast is provided for the guidance of the national sections and is not to be considered for adoption by the Commission until the Ninth Annual Meeting in 1962.

iv. The Administrative Report for 1961 (INPFC Doc. 463), by the Executive Director, was reviewed by the Committee on Finance and Administration. The Committee recommended to the Commission that it accept the report as a record of the activities of the Secretariat during the year. The report in question forms Part II of this annual report.

v. The Committee reviewed a report entitled "Comments on the form and nature of the reports submitted by Canada and the United States in 1961 under Articles III (1) (c) (iii) and X (2) of the Convention" (INPFC Doc. 464). The Committee recommended that the report be accepted by the Commission and suggested that copies should be made available to those concerned with the preparation of future reports under these Convention articles. The Secretariat was instructed to discuss the nature of future submissions under these articles with appropriate persons in each national section, with a view to recommending procedures which would adequately meet the requirements of these articles and, at the same time, minimize and simplify the work required annually to prepare these reports. This assignment is to be carried out in advance of the beginning of the 1962 fishing season.

vi. The Committee on Finance and Administration recommended that the Commission establish a medical insurance plan for permanent staff members.

vii. The Committee recommended to the Commission that the Working Capital Fund be reduced by the amount of $3,864.75, Canadian funds, and that the amount thus obtained be authorized for use by the Secretariat to assist in defraying costs of printing an unforeseen and extraordinary volume of material approved for publication under the current budget. It was also recommended that, for the time being, the Working Capital Fund shall be maintained at the amount of $2,000, Canadian funds.

viii. The Committee on Finance and Administration recommended that the first plenary session of the Ninth Annual Meeting of the Commission should be held on Monday, November 12, 1962, in Seattle, Washington. It was further recommended that the period beginning on October 29 and extending to the end of the Ninth Annual Meeting should be designated as the period within which the time and place of committee sessions might be arranged by consultation between the respective chairmen and the Secretariat. The Committee took note of the amount of time required in 1961 for sessions of the various scientific sub-committees and working groups and requested that sufficient time be provided, even prior to October 29, if necessary, for these groups to complete their work without unduly crowding the schedules of the other committees and the Commission.

ix. The Committee on Finance and Administration tentatively recommended that the Tenth Annual Meeting should be held in Vancouver, British Columbia, at approximately the same time as previous annual meetings.

8. Implementation of the Provisions of the Protocol

8 (a) The Requirement

The Protocol to the International Convention for the High Seas Fisheries of the North Pacific Ocean requires the Commission to determine if salmon originating in the rivers of Canada and the United States of America intermingle in the ocean with salmon originating in the rivers of Asia. If such areas of intermingling are found, the Commission is required to conduct suitable studies to determine a line or lines which best divide salmon of Asiatic origin and salmon of Canadian and United States of America origin and to determine whether it can be shown beyond a reasonable doubt that the new line or lines more equitably divide such salmon stocks than the provisional lines specified in the Annex to the Convention. (The provisional line lies on or very near the meridian of 175° West.) In accordance with these determinations the Commission shall recommend that such provisional lines be confirmed or that they be changed in accordance with the results of its investigations.

Early in the Commission's investigations in relation to the Protocol problem, it became clear that salmon from certain areas of the two continents intermingled over a broad area of the North Pacific Ocean. The investigations each year have confirmed the existence of intermingling of the continental stocks. It therefore became necessary to proceed with the second por-

tion of the Protocol assignment—to conduct studies to determine a line or lines which best divide salmon of Asiatic origin and salmon of North American origin. At this point, the Commission found that it could not reach agreement on the intent of the Protocol. The action taken by the Commission with respect to this impasse is described in the following section of this report.

8 (b) Interpretation and Implementation of the Protocol

During its Sixth Annual Meeting, on November 7, 1959, the Commission decided to inform the Contracting Parties that it had been unable to arrive at an agreed interpretation of the intent of the Protocol to the Convention. Therefore, the Commission requested that the Contracting Parties provide it with such an interpretation as soon as practicable. At the present (Eighth) annual meeting, the Commission had not yet received an agreed interpretation of the Protocol from the Contracting Parties. Therefore, the Commission could make no recommendation regarding the implementation of the Protocol. That is, the Commission found itself unable to recommend either that the provisional lines which delimit salmon fishing be confirmed or that they be changed, because it does not have an agreed principle to be used in applying the results of research to the question of location of new dividing lines for the salmon stocks. The practical result is that the provisional dividing lines for salmon fishing remain in effect.

8 (c) Analysis of Research Results

The Commission, acting through its Committee on Biology and Research carried on its continuing task of promoting, coordinating and analyzing the results of research on salmon on the high seas in connection with the problems raised by the Protocol to the Convention. Research in 1961 continued on a very large scale, as can be determined by examination of the summaries of research by each country which form Part III of this annual report. The scale of the program has necessitated dividing the work of the Committee on Biology and Research into assignments to a large number of sub-committees, working parties, etc.

For the second consecutive year, the Committee on Biology and Research continued its practice of having scientist-rapporteurs prepare reports on the origin, distribution, abundance and intermingling of each of the various species of salmon (coho and chinook were combined). These scientists, working with assistance available from correspondents appointed by the other member sections, prepared reports, as individuals, on the species with which they were concerned. The individual reports on each species were presented to the Committee on Biology and Research which referred them to sub-committees for each species. Using the rapporteurs' reports and other available materials as required as the basis for their work, the sub-committees produced jointly agreed reports on each species. The rapporteurs were Mr. F. C. Cleaver of the United States for sockeye, Dr. T. Ishida of Japan for pink salmon, Dr. M. P. Shepard of Canada for chum salmon and Mr. H. Godfrey of Canada for coho and chinook salmon. These individuals, assisted by scientists from each of the other countries, formed the sub-committees which prepared the reports on each species. These reports, which were submitted to and adopted by the Commission, are summarized below.

i. *Distribution of sockeye salmon.* The report of the Sub-Committee on Sockeye Salmon, as adopted by the Committee on Biology and Research and the Commission, is contained in full in INPFC Document 491, the Report of the Committee on Biology and Research for 1961. The following summary of the report on sockeye salmon is taken verbatim from Document 491:

" Research carried out from 1956 to 1961 has shown the following:

" 1. Sockeye salmon enter their home streams from May until October, but for any stream the duration of heavy migration is usually less than one month.

" 2. Sockeye salmon are found from North America to Asia in the North Pacific Ocean and Bering Sea during the spring and summer.

" 3. The oceanic distribution of sockeye salmon appears to shift southward in the winter and northward in the summer.

" 4. From the results of tagging and parasite studies immature Asian sockeye salmon have been shown to migrate as far east as 170° West longitude in the North Pacific Ocean and 175° West longitude in the Bering Sea. Immature Bristol Bay sockeye have been shown to migrate as far east as 145° West longitude and as far west as 173° East longitude in the North Pacific Ocean, and as far west as 170° East longitude in the Bering Sea.

" 5. In May and June maturing Kamchatkan sockeye salmon predominate in the North Pacific Ocean from Kamchatka to about 175° East longitude and Bristol Bay sockeye salmon predominate westward to about 180° longitude. Maturing Kamchatkan fish may be found

eastward at least to 159° West longitude and Bristol Bay fish are found to 167° East longitude. In the Bering Sea, the maturing sockeye salmon east of 180° longitude are almost entirely of Bristol Bay origin. Because there are so few data west of 180° longitude in the Bering Sea we cannot make any judgement concerning the regularity of dominance by Kamchatkan or Bristol Bay maturing sockeye salmon in this area.

" 6. The areas dominated by Kamchatkan or Bristol Bay maturing sockeye salmon in late May and in June appear to have been consistent in 1956, 1957, 1958, 1959 and 1960."

ii. *Distribution of pink salmon.* The report of the Sub-Committee on Pink Salmon, as adopted by the Committee on Biology and Research and the Commission, is contained in full in INPFC Document 491, the Report of the Committee on Biology and Research for 1961. The following summary of the report on pink salmon is taken verbatim from Document 491:

" The major populations of pink salmon found in different regions of offshore waters are indicated by (1) tagging results, (2) morphological, serological and parasitological studies, and (3) studies of fishing data and other information.

" It is clear that at least four stocks of pink salmon occur in the Aleutian waters. They are:

" 1. Asian stocks (principally those from East Kamchatka)
" 2. Western Alaskan stocks (N. side Alaska Peninsula to Kotzebue Sound)
" 3. Local Aleutian Island stocks
" 4. Central Alaskan stocks.

" Of special interest are the results of 1961 tagging by Canada, Japan, and the United States which indicate several new features of pink salmon distribution. For the first time tagging in Aleutian waters in an odd-numbered year yielded returns from Western Alaska. Recoveries on the high seas indicated an important movement toward East Kamchatka as in previous odd years. Tagging in the Gulf of Alaska showed that pinks from Southeastern Alaska were present to 155°W. Pink salmon were shown to make extensive east and west and north and south migrations from widespread release points within the Gulf.

" Scale studies indicate that the pink salmon of East Kamchatka were present as far east as 155°W.–160°W.

" Studies of fishing data reveal that year-to-year fluctuations in abundance of pink salmon in offshore waters of the Bering Sea and Aleutian regions have closely coincided with the fluctuations in the coastal catch of East Kamchatka pinks. From coastal catch statistics and tag returns it is apparent that Western Alaska pink salmon populations were far smaller than East Kamchatka populations in 1957 and 1959. Also, tagging and other data show that the range of distribution is not necessarily diminished in years of low abundance, although proportions of different intermingled stocks would be expected to change according to their relative abundance.

" From the results of scale analysis and tagging, the offshore distribution of Central Alaska pinks is assumed to be westward from 140°–145°W. The western limit of their distribution remains to be studied.

" Less data on the ocean distribution of Southeastern Alaska-British Columbia pink salmon is available than for other stocks studied. The western limit of distribution reaches at least as far west as 160°W., judging from the results of scale studies. Tagging in 1961 has shown them to be present as far west as 155°W.

" Year-round studies are needed in the Gulf of Alaska where so many stocks are present.

" Conclusions to date as to intermingling of Asian and North American pink salmon and their proportions are as follows:

" (1) The only extensive intermingling of Asian and North American pinks demonstrated to date occurs between East Kamchatka and Western Alaska populations.

" (2) Evidence shows Western Alaska pinks present westward at least to the Central Aleutians (177°E.) and Asian pinks present eastward to at least 155°W.–160°W. Of course, Aleutian Island stocks must also be intermingled, at least as far west as 173°E.

" (3) In 1957 and 1959 East Kamchatka fish dominated Aleutian waters. In even years, pinks have been relatively scarce in Aleutian waters. Data indicate that Western Alaska pinks are more abundant in Aleutian waters in even years than in odd years.

" (4) Recently Central Alaska pinks have been shown to 168°W., and Southeastern Alaska-British Columbia pinks have been shown as far west as 160°W., but the degree to which they also may intermingle with Asian pinks is uncertain because of insufficient sampling offshore south of the Eastern Aleutians and Alaska Peninsula at the proper times."

iii. *Distribution of chum salmon.* The report of the Sub-Committee on Chum Salmon, as adopted by the Committee on Biology and Research and the Commission, is contained in full in INPFC Document 491,

the Report of the Committee on Biology and Research for 1961. The following summary of the report on chum salmon is taken verbatim from INPFC Document 491:

" (A) Asian chum salmon stocks are more abundant than those originating in North America. On both continents, chums are widely distributed, inhabiting streams and rivers of northern Japan, the northern Japan Sea, Okhotsk Sea, North Pacific, Bering Sea and Arctic Ocean coasts of the U.S.S.R., and of the entire North American coastline from Oregon northward to the Mackenzie River on the Arctic Ocean and westward in the Aleutians to Attu. On both continents the more northerly runs spawn in the summer (mainly June to September) whereas in southern streams (especially Hokkaido and southern British Columbia) the chums spawn mainly in the autumn (September to January). The summer-run U.S.S.R. stocks of the Sea of Okhotsk and Kamchatka are the most abundant of all.

" (B) Chum salmon, migrating to sea as fry in the spring and early summer, become distributed throughout most of the North Pacific and Bering Sea north of the Subarctic front by the time they have completed their first year at sea.

" (C) Tagging from 1956 to 1961 indicates that both mature and immature chums originating in North America and Asia intermingle extensively in the central North Pacific and Bering Sea.

" a) Chums tagged as far west as 180° in the North Pacific Ocean south of the Aleutians have been recovered in North America and some tagged as far east as 153°W. have been recovered in Asia.

" b) Chums tagged in the Bering Sea as far east as 170°W. have been recovered in Asia and some tagged as far west as 175°W. have been recovered in North America. Tagging in this region, however, was not as extensive as it was near the Aleutians and consequently the results may not indicate the full range of intermingling.

" c) In the North Pacific Ocean and in the Bering Sea, recoveries from tagging of chums westward from 175°W. were made mainly in Asia whereas those from tagging eastward from 170°W. were made mainly in North America. From tagging between 170°W. and 175°W. the numbers of recoveries in Asia and North America were almost equal.

" d) In the area of intermingling, chums originating in both northern (summer-run) and southern (autumn-run) streams of Asia were present. Almost all the North American chums present came from northern (summer-run) Alaskan streams draining into Bristol Bay and the Bering Sea.

" (D) Studies of scale characteristics on chums collected in 1956 and 1957 also suggest that intermingling occurs over a broad area. Although the methods used require further testing, the results, in general, parallel those of tagging studies.

" a) During May and June, samples taken in both the North Pacific Ocean and Bering Sea westward from 174°W. contained high proportions of chums with scales similar to those of chums sampled in the northern U.S.S.R. and only small proportions of chums similar to those of North American chums. On the other hand, samples taken eastward from 170°W. contained high proportions of chums with scales of the North American types and smaller proportions of chums with Asian-type scales.

" b) During July to September, samples taken westward from 175°W. in the Bering Sea and North Pacific Ocean generally contained higher proportions of northern Asian-type chums than North American-type chums. Samples taken eastward from 175°W. in the Bering Sea and North Pacific Ocean generally contained higher proportions of North American type chums than northern Asian type chums. However, a number of samples from the central Gulf of Alaska contained significant proportions of chums with scale characteristics of northern Asia type, and a number of samples taken south of the Aleutians as far west as 172°E. contained significant proportions of chums with scale characteristics of North American type.

" c) Chums originating in the British Columbia-Southeastern Alaska area extend throughout the northern Gulf of Alaska. Some may migrate far westward into the central Aleutian area.

" (E) Considering the results of tagging data collected from 1956–61 and scale data from 1956 and 1957, it is concluded that intermingling between chums of Asian and continental North American origins occurred at least between 153°W. and 180° and possibly as far west as 170°E. and as far east as the central Gulf of Alaska. The data suggest that, for maturing fish during May and June, the approximate division between areas where North American and Asian chums predominated lay somewhere between 170°W. and 175°W. near the Aleutians and probably between the same longitudes further north in the Bering Sea. Later in the season (from July to September) most mature chums bound for the summer-run areas of the northern U.S.S.R. and northern Alaska had left the central Aleutian area, leaving behind mature chums bound mainly for the late-spawning streams of Asia and immature chums. Among samples containing mixtures of matures and immatures taken in the central ocean area, the approximate division between chums with Asian type scale characteristics and those with

North American type scale characteristics appeared to lie at about 175°W."

iv. *Distribution of coho salmon.* The report of the Sub-Committee on Coho and Chinook Salmon, as adopted by the Committee on Biology and Research and the Commission, is contained in full in INPFC Document 491, the Report of the Committee on Biology and Research for 1961. The following summary of the report on coho salmon is taken verbatim from INPFC Document 491:

" 1. In Asia coho salmon occur from at least as far north as the Anadyr River, south to Hokkaido. In North America they are present from at least as far north as Cape Thompson in the Chukchi Sea, south to the California coast. On both continents they are produced in numerous small coastal streams as well as in the tributaries of larger rivers.

" 2. The main production areas of the coho salmon in Asia are the west and east coasts of Kamchatka. In North America those areas that have provided more than 95 percent of the recent average annual catch extend from Central Alaska to Oregon.

" 3. In recent years coho salmon have constituted about 3 percent of the average total Asian catch of Pacific salmon, and in North America about 11 percent. However, there are considerable differences in certain areas in the relative importance of coho salmon catches as compared with those of the other species.

" 4. Both in Asia and in North America coho of ages 3_2 and 4_3 form the great majority of the adult fish. They return late in the year following that in which they entered the sea. In the more northern areas of both continents fish of age 4_3 may equal or exceed in numbers those of age 3_2; in contrast, farther south fish of age 3_2 are considerably more abundant than those of age 4_3.

" 5. It was agreed that most of the Japanese mothership and land-based catches have been taken relatively close to the Asian coast and probably were almost wholly of Russian origin. Thus, from the available statistics it was determined that in recent years the total catches of Asian and North American coho were in the approximate ratio of 4.6 to 7.5 millions of fish. Lack of adequate escapement data, and of statistics on coho catches in certain areas, made it impossible to estimate the total stocks on the two continents.

" 6. In general, adult coho salmon return to coastal waters late in the season as compared with the other species, and the runs tend to be prolonged. The times of their occurrence in different coastal fisheries vary, and show a tendency to be progressively later southwards.

" 7. Indications of the ocean distribution and migrations of coho salmon were obtained from analyses of mothership and research vessel catches, and from tagging results.

" In the course of the Commission's research coho salmon have been taken on the high seas, beyond the range of coastal fisheries, as far south as 45° North latitude in the eastern North Pacific, and as far south as 42.5° North latitude in the western North Pacific. However, they are also known to occur at distances at least 20 miles from the southern California coast.

"Adult Asian coho appear in numbers in the more northern waters of the western Pacific, south of the Aleutian Islands and off southeast Kamchatka, late in the season as compared with the other species, and mainly during late July and August. They approach the northern Kurile Islands and southeast Kamchatka over a broad front, mainly from the south and southeast.

" During late spring and summer adult coho were found to be rather widely dispersed in the central Gulf of Alaska. As the season advanced they appeared in greater numbers closer to the coasts, and by late August and in September were virtually absent from the central waters of the Gulf. At no time were coho found in central waters of the Gulf in large concentrations comparable to those that occurred along the south Aleutian Islands and off southeast Kamchatka. Nor at any time were they found in the Gulf of Alaska in concentrations compatible with their abundance on the North American continent, until such time as they were being taken in the coastal fisheries.

" Coho tagged just south of 50° North latitude and to the east of the northern Kurile Islands gave returns both from the northwest coast of the Okhotsk Sea and from the west coast of Kamchatka. From taggings further north, off the Southeast Kamchatka coast, there were relatively many recoveries in East Kamchatka and several in West Kamchatka.

" From among coho tagged directly south of Adak there were returns from both Western Alaska and East Kamchatka.

" Tagging in the Gulf of Alaska, mainly in coastal waters, gave returns that were mostly from nearby fisheries or streams. One immature coho from Oregon had travelled at least 1200 miles, and had reached a length of 31 cm., during its first season in the ocean.

" 8. Tagging results provided positive evidence of some intermingling directly south of Adak between Western

Alaska and East Kamchatka coho stocks, but the extent of intermingling between these stocks could not be determined.

" From a consideration of all the pertinent data presented it was concluded that it is unlikely that there is extensive intermingling between adult Asian coho and adult North American coho that originate in the Gulf of Alaska and farther south. However, additional research would be required to substantiate this more definitely.

" Recent studies have indicated certain differences in scale patterns between Asian and North American coho that might be useful in determining the origin of coho taken in areas of intermingling. Further research is necessary in this connection.

" No other types of racial studies have been reported for this species.

" 9. Consideration was given to the probable relationships between the ocean distribution and migrations of coho salmon and such environmental and biological factors as water temperatures, food requirements and food availability, maturity and ocean age.

" 10. Vertical distribution studies have indicated that on the high seas coho salmon have usually been caught only near the surface, and in greatest numbers within the upper 10 meters. However, they have been taken on occasions at greater depths, and as deep as between 20 and 35 meters, approximately."

v. *Distribution of chinook salmon.* The report of the Sub-Committee on Coho and Chinook Salmon, as adopted by the Committee on Biology and Research and the Commission, is contained in full in INPFC Document 491, the Report of the Committee on Biology and Research for 1961. The following summary of the report on chinook salmon is taken verbatim from INPFC Document 491:

" 1. In North America chinook salmon have been found as far north as Cape Thompson in the Chukchi Sea, south to California below San Francisco. They spawn mainly in the larger rivers and their tributaries (e.g., the Sacramento, Columbia, Fraser, Skeena, Nushagak and Yukon Rivers, and other major river systems). Many small coastal streams also contribute to the total production of chinook salmon in North America.

" In Asia the species occurs from at least as far north as the Anadyr River, and south to the Amur Firth and the islands of Sakhalin and Hokkaido. In Asia, too, the larger rivers are the major producers, mainly those of East and West Kamchatka, and particularly the Kamchatka River.

" 2. In North America and Asia chinook salmon have constituted about 5 percent and much less than 1 percent respectively of the total average annual catches of Pacific salmon in recent years. However, their relative importance varies between areas, and in certain North American areas is considerably greater.

" 3. There is considerable variation among chinook salmon in the duration of both their fresh-water and ocean residence. Most proceed to sea during the same year of hatching but some considerably later after emergence than others. Among some stocks (e.g., up-river Fraser River and Columbia River stocks) a large proportion spends a year in fresh water before making the seaward migration. The duration of their ocean residence ranges from returning in the same year of their entry to the sea, up to 5 or 6 years later.

" 4. The total average annual catch of chinook salmon in recent years by the U.S.S.R. and the Japanese mothership and land-based fisheries has been about 200,000 as compared with the North American average catch of 3,500,000. Lacking sufficient information on escapements, and adequate catch statistics for some areas, it was not possible to make an estimate of the present sizes of the chinook stocks on the two continents.

" 5. On both continents chinook salmon enter coastal waters from early to late in the year, mainly from May to September. The timing of peak catches in the North American fisheries, from Western Alaska to California, shows considerable variation, and is described in some detail in the text. In the major Asian fishery, that of the " Kamchatka Fishery " region, apparently about two-thirds of the total catch is made in June.

" 6. In describing the ocean distribution of chinook salmon, it was not possible at this time (except in a few instances) to distinguish between immature and maturing fish, because of the lack of the necessary data.

" In May chinook salmon are widely dispersed in the North Pacific, and are present at least as far north as the Aleutian Islands. Chinooks must also be present in the Bering Sea in May since catches are made in early June in Western Alaska rivers. Relatively large catches were made in the Bering Sea in June.

" During August the greatest concentrations were found immediately south of the Aleutians, mainly west of 175° West longitude, and off southeast Kamchatka and the northern Kurile Islands.

" Information on the sizes of chinooks taken in the

mothership fishery suggested that immature fish progressively increase in numbers in this fishery as the season advances.

"At no time from May to September were chinooks found in large concentrations in the Gulf of Alaska beyond the range of the coastal fishery areas. Throughout the season they were caught in small numbers at widely dispersed locations in the Gulf.

" Little information has yet been gained from the high seas tagging of mature chinook salmon, since to date only a few returns have been reported. The recoveries of immature fish indicate that some make particularly extensive ocean migrations.

" 7. Although the information gained from the tagging of chinook salmon is meager, it does suggest that immature chinooks of Asian and North American origin intermingle in the North Pacific Ocean and Bering Sea.

" 8. No information was presented regarding racial studies of chinook salmon. However, it was reported within the Sub-Committee that some progress in this regard is being made through scale studies, serology, and a new marking technique."

vi. *Oceanography of the North Pacific.* Oceanographers from research agencies in Canada, Japan and the United States which are participating in the Commission's research program are members of a sub-committee which coordinates oceanographic investigations in the northern North Pacific Ocean and analyzes and reports the results of the investigations. The oceanographers did not present a report of current progress in research at the Commission's 1961 Annual Meeting. Although field collection of oceanographic data and its analysis have continued, emphasis has been placed on the joint reporting of the results of the oceanographic investigations. Progress in this activity is described under item 8 (d) of this report—Reporting of the results of research. Tentative plans for oceanographic research in 1962 are described in item 8 (f) of this report.

8 (d) Reporting of the Results of Research

i. *Research reports from national sources.* The Commission publishes research bulletins, which contain scientific papers submitted from national sources and those prepared by the joint efforts of scientists from the member countries. All papers pertain to the Commission's research programs. Before submission to the Commission for approval for publication, each paper must obtain the approval of three editorial referees. The referees in 1961 were Dr. Hiroaki Aikawa for Japan, Mr. Donald L. McKernan for the United States and Dr. Alfred W. H. Needler for Canada.

In the interval between the Seventh and Eighth Annual Meetings, the referees gave their approval to three papers. During the Eighth Annual Meeting, the editorial referees recommended publication of four additional papers from national sources. In addition to these papers, two others had their approval deferred to allow more time for study of their contents.

ii. *Comprehensive joint report on high seas salmon.* At the Sixth Annual Meeting of the Commission the Committee on Biology and Research instructed the editorial referees to " develop plans for the eventual reporting of the results of the research program as a whole ". At the Seventh Annual Meeting the referees recommended that a joint comprehensive report on the origin, distribution, abundance and intermingling of continental stocks of Pacific salmon on the high seas should be prepared and that initial steps toward its preparation should begin at that time. To that end, the referees outlined the contents of a joint comprehensive report consisting of eleven chapters. They recommended that preparation of the six initial or background chapters of the report begin immediately. At the Eighth Annual Meeting, the referees reviewed the progress in preparation of each of these chapters and reported to the Committee on Biology and Research and the Commission as follows:

Chapter I—Introduction, outline and review of previous knowledge. This chapter was assigned to the Secretariat for preparation of a draft. Pressure of other work has made it impossible for the Secretariat to take more than preliminary action on the preparation of the draft. The Secretariat intends to place a draft of Chapter I in the hands of the Editorial Referees by late winter or early spring in 1962.

Chapter II—A review of the life history of the various species. This chapter is being prepared by one or more scientists in each country, the division of effort being, in general, by geographic regions and by species. The Japanese authors of this chapter have completed drafts of their work and submitted them to the Secretariat at this Annual Meeting, for translation and distribution to the referees and the Canadian and United States authors of this chapter. A draft report on the life history of pink salmon in British Columbia was received at this session as an indication of the approach being used by the Canadian authors. The Editorial Referee for the United States reported that efforts would be made to have the United States con-

tributions to this chapter of the joint report ready in draft form during the summer of 1962. Drafts from the Canadian author for this chapter will also be scheduled for submission in the spring or early summer of 1962.

The Editorial Referees, while noting the need for coordination in such matters as geographical coverage, timing of preparation, etc., between work of the various authors concerned with this chapter, also stressed the value of the individual approach by each scientist concerned with preparation of portions of this chapter.

Chapter III—Spawning populations of Pacific salmon. The Editorial Referee for Japan stated that the first drafts of the portions of this chapter assigned to Japanese authors had been submitted to the Secretariat at this Annual Meeting for translation and distribution to the referees and the United States and Canadian authors of Chapter III. The Editorial Referee for Canada stated that the Canadian authors for this chapter had assembled much of the data required for its preparation and indicated that the first draft of the portions of the chapter assigned to Canadian authors would be completed by the summer of 1962. The Editorial Referee for the United States reported that the portions of this chapter assigned to United States authors were partially prepared and that a draft would be completed by the summer of 1962.

Chapter IV—Historical statistics. This chapter has been assigned to the Secretariat. All of the basic tables have been compiled. Corrections and additions have been made and a rough draft has been prepared. The Secretariat plans to submit the final draft in the summer of 1962.

Chapter V—Offshore distribution of salmon. The working party which is engaged in preparation of this chapter of the joint report has completed the larger portion of its work. Another meeting of the authors will be required in the first part of 1962. A draft of the completed chapter should be in the hands of the Commission prior to the 1962 Annual Meeting. The purpose of this chapter is to bring together, from all known sources, catch, effort and biological data concerning high seas salmon. These data will be presented in detail as a convenient reference source for scientists engaged in specialized studies.

Chapter VI—Oceanography of the Subarctic waters of the North Pacific. The oceanographers engaged in preparation of this chapter have made substantial progress and anticipate completion of a draft of the entire report during the first part of 1962. The working group anticipates that another meeting of its members will be required to expedite completion of the chapter.

At the Eighth Annual Meeting the Commission approved recommendations for preparation of four additional chapters of the joint report. These chapters are described as follows:

Chapter VII—Sockeye salmon in offshore waters. Origin of stocks. Abundance, year by year. General oceanic distribution. Time and age in the sea. Recognition of origin. Maturity and immaturity. Ecological relationships. Vertical distribution. Migrations. Specific description of distribution and intermingling each year. Factors controlling intermingling. Stocks not involved in intermingling.

Chapter VIII—Pink salmon in offshore waters. Same basic contents as Chapter VII.

Chapter IX—Chum salmon in offshore waters. Same basic contents as Chapter VII and VIII.

Chapter X—Coho, chinook and masu salmon in offshore waters. Same basic contents as Chapters VII, VIII and IX.

In order to begin production of these chapters, the following steps were approved: Each national section designated scientists as members of working parties for each of the chapters. The working parties were instructed to assemble data and records and to prepare factual reports, as complete as possible, on the species with which they are concerned. It was noted that each working party should have as a goal agreement on interpretation of the data and conclusions therefrom; however, the members of the working group should also express their individual views regarding interpretations and conclusions from data in cases where objective agreement cannot be reached. The working groups on Chapters VII, VIII, IX and X were instructed to make substantial beginnings on their assignments prior to the 1962 Annual Meeting of the Commission. No action was taken at this annual meeting toward preparation of Chapter XI—"A summary of the composite distribution and intermingling of all species of salmon in offshore waters."

8 (e) Future Program of Research under the Protocol

The Commission adopted, at its 1961 Annual Meeting, a broadened program for research on salmon. Its purpose is to study more aspects of the salmon's life in the ocean and to apply new approaches

and techniques in order to obtain more complete answers to the questions raised by the Protocol. The scientists on the Committee on Biology and Research expressed the view that, although the research program has made great advances, there are still serious gaps in knowledge of the distribution, growth and survival of salmon in the ocean and in understanding of the variations of the abundance and migrations of the various stocks. Other aspects of the Commission's work would also benefit from fuller knowledge of salmon in the ocean. The broadened program of research on salmon includes the following items:

i. Sampling and racial studies to determine distribution and movements of salmon stocks. The need for completion of analyses of data and material already on hand is emphasized, in order to obtain as much knowledge as possible of the distribution and movements of all species and stocks of salmon. Even after completion of these analyses it is believed that serious gaps in knowledge will remain—e.g., lack of information on salmon distribution and movements in some areas and at some seasons. Further sampling by research vessels and study of data from commercial fisheries will be required to fill these gaps. Careful review of detailed plans for coordinated sampling is recommended.

ii. Tagging. An extended and coordinated program of tagging in offshore as well as inshore waters, using the suitable techniques now available, could give much better coverage than heretofore of the areas occupied by salmon. Present knowledge of the high-seas distribution and movements of some major stocks is very incomplete. Tagging can also contribute to knowledge of growth and mortality rates. Extension and better coordination of tagging programs have already been recommended. The importance of this work is reaffirmed.

iii. Distribution and movements of young salmon. Little is known of the movements of young salmon from their rivers of origin or of their distribution and abundance on the high seas. A special attempt should be made to fill this serious gap. Knowledge of the distribution and movements of young salmon is basic to an understanding of their distribution and abundance as adults. It would permit sampling to study growth and mortality rates in relation to environmental factors, and to improve predictions of abundance and timing of adult runs. A special effort to develop suitable techniques for quantitative sampling of young salmon on the high seas seems to be required as a first step before a broad program can be formulated.

iv. Growth and mortality of salmon during their high-seas life. Knowledge of growth and mortality is necessary to assess the effects of catching salmon at various stages of their life, and growth probably influences the age at which sockeye and chum salmon mature and return to their parent streams. Techniques for studying growth and mortality are already under review. They involve work both at sea (tagging, sampling) and inshore (scale studies, sampling).

v. Factors governing vertical and horizontal movements of salmon on the high seas. Better knowledge of the vertical and horizontal movements of salmon on the high seas in relation to environmental factors is needed to interpret the results of commercial or exploratory fishing and to assess availability (the proportion caught by a given fishing effort). It can also throw light on variations in routes of migration, which are pertinent to the problems raised by the Protocol.

vi. Food and feeding of salmon. Better knowledge of variations in the abundance of salmon food, both from time to time and from place to place, is needed to understand the distribution of salmon and variations in their growth and survival. Variations in feeding activity of salmon may be related to their migrations and are pertinent to the importance of food supply.

vii. Productivity. The supply of salmon food depends ultimately on primary productivity (the conversion of inorganic materials and energy into living plants) and on the production of zooplankton. Techniques of studying productivity are improving rapidly. Discovery of its seasonal, year-to-year and geographical variations would lead to a better understanding and prediction of salmon distribution and growth. Coordinated surveys would be required.

viii. Physical oceanography. Water movements and the varying vertical and horizontal distribution of physical and chemical properties can affect the distribution, movements, growth and survival of salmon both directly, by influencing the behaviour of the salmon themselves, and indirectly, by influencing their food or predators. It is especially important to understand the major current systems, and variations in their course and strength. Physical oceanography in the North Pacific has reached a stage at which it is clear that coordinated ocean-wide observations would not only produce a more complete picture of the conditions influencing salmon but can also be expected to lead to some degree of prediction.

ix. Implementation. An increased effort to coordinate the research activities of the three countries

is needed to carry out the broadened program outlined above. To this end it is recommended: (1) that working parties be established to develop and coordinate plans annually for the salmon studies (Items *i* to *vi*), for productivity studies (Item *vii*) and for physical oceanography (Item *viii*); (2) that special attention be given to planning of the programs of reseach vessels in order to obtain maximum use and coverage.

8 (f) Plans for Research on Protocol Questions in 1962

The Commission develops its own research program and is responsible for its coordination and joint interpretation of results. The actual research is carried out by the cooperating agencies of the member governments, principally the United States Bureau of Commercial Fisheries, the Fisheries Research Board of Canada, and the Fisheries Agency of Japan.

It was the view of the scientists assigned to development of the research program for 1962 that, as far as possible, plans for 1962 should reflect the objectives expressed in Part 8(e) of this report. The following tentative plans were submitted for research in 1962:

Tagging. Canada proposed to use four vessels for tagging salmon on the high seas east of about 160°W. longitude. Japanese experts aboard each vessel would assist in the use of longlines for capturing salmon. The period of operation would be from April to August, with the possibility that one vessel might be operated for a considerably longer period. Japan proposed to use two vessels for tagging throughout the fishing season, using longlines for capturing salmon. One vessel would operate in the Aleutian area and the other farther west. The United States proposed to use four purse seine vessels for a total of about 16 vessel months. Two would operate in the Gulf of Alaska, north of 55° N. latitude. The other two would operate in the Aleutian area. Emphasis would be on improvements in tagging techniques and on the tagging of young salmon.

Racial studies. Canada will continue to make scale studies for the purpose of distinguishing stocks and discovering their distribution on the high seas. Studies on chum salmon and on the sockeye of Rivers and Smith Inlets, British Columbia, will be included.

Japan will develop further the scale studies made during 1961, especially in relation to high seas samples. Attention to five species is contemplated. Further examination of serological methods will be undertaken.

The United States will conduct basic studies on methods of scale examination and will re-examine the use of scales for distinguishing Asian and North American stocks of sockeye, chum and pink salmon. Preliminary work on chinook scales may also be undertaken. Morphometric studies will be concentrated on the analysis of 1961 material. It is anticipated that the commissioning of a large vessel in 1962 will provide facilities for the expansion of serological studies.

Distribution and sampling of salmon on the high seas. Japan will use a research vessel in areas outside those occupied by motherships. During the first half of the fishing season the vessel will operate in the eastern parts of the North Pacific and the Bering Sea. During the second half of the season, it will operate in western areas of the North Pacific and the Bering Sea. Investigations on young salmon and on the vertical distribution of salmon will be undertaken.

The United States anticipates that a large research vessel (179 ft.) will be commissioned in 1962 for year-round investigations of salmon in the Gulf of Alaska and the Aleutian area, from July 1. Chartered vessels will be used for two to three vessel months in the spring in the Aleutian area. The operations of the large vessel will also be supplemented by one or possibly two chartered vessels after July 1.

Productivity, plankton and salmon food. Canada plans to continue intensive investigations on primary productivity in the eastern North Pacific and also to resume studies on zooplankton and on salmon food in relation to salmon growth and abundance.

Oceanography. Canada will continue research in physico-chemical oceanography including: (a) a synoptic survey of the area north of 40°N. and east of 160°W. in the early summer; (b) continued observations at Ocean Weathership Station "P" (50° N., 145°W.) and frequent oceanographic sections from there to the North American coast, to study variations in the circulation in the Alaskan gyral; (c) analysis of many observations from various sources (research vessels, etc.) to study seasonal changes in conditions in the upper layers; and (d) monthly computations of water transports in the North Pacific from data on barometric pressures.

Japan will consolidate the oceanographic data obtained by the research fishing vessels. It is not certain whether funds will permit the operation of a separate oceanographic research vessel.

The United States hopes approximately to triple its present effort in this field after July 1.

General. Scientists planning 1962 research agreed on the importance of sampling and tagging in the western Gulf of Alaska, south of the Alaska Peninsula.

It was emphasized that at this time detailed plans for 1962 can only be tentative. The desirability of close coordination between the agencies contributing to the program was stressed. On these accounts, it was recommended that a working party meet early in 1962 to effect this coordination at a time when plans can be better finalized.

It was agreed that catch statistics and scientific data from the mothership fishery are important to research on questions raised by the Protocol and that exchange of scientists between countries is valuable to the research program.

9. Implementation of the Provisions of Article III (1) (a) of the Convention (Abstention)

Under the provisions of the International Convention for the High Seas Fisheries of the North Pacific Ocean, Japanese fishermen abstain from fishing salmon and halibut in the eastern Bering Sea and the eastern North Pacific Ocean. Japan also abstains from fishing herring off the Pacific coast of Canada and off the coast of the United States south of the entrance to the Strait of Juan de Fuca. Canadian fishermen abstain from fishing salmon of United States origin in the eastern Bering Sea. The stocks and areas currently under abstention are defined in the Annex to the Convention, the text of which is printed in the Commission's Annual Report for 1959.

At its Eighth Annual Meeting, the Commission again studied the qualifications of the stocks of fish which remain under abstention. As in the past, the Commission utilized the services of a special committee, known as the Ad Hoc Committee on Abstention, to conduct the studies. This Committee and its Scientific Sub-Committee are charged with receiving and reviewing the evidence submitted to the Commission by the various Contracting Parties with respect to the qualification of the stocks under abstention. The work of this Committee is conducted on an *in camera* basis. The Commission, after receiving and adopting the report of the Ad Hoc Committee on Abstention at an *in camera* session, reported the results of its consideration of abstention questions at its final its final plenary session. The following is the verbatim text of the report on the subject of the abstention determinations as read into the record of the Third Plenary Session of the Eighth Annual Meeting:

"I. With respect to the herring stock off the coast of the United States, south of the entrance to the Strait of Juan de Fuca, which in the judgment of the United States National Section was intended for removal from the Annex in 1959 along with herring stocks off other portions of the coast of the United States, the Commission adopted the following resolution:

"Whereas the International North Pacific Fisheries Commission, in performing the functions described in Article III (1) (a) of the Convention, has determined that the herring stocks off the coast of the United States of America south of the entrance to the Strait of Juan de Fuca no longer meet the conditions of Article IV of the Convention, it is recommended:

"1. That the stocks of herring described above be removed from the Annex to the International Convention for the High Seas Fisheries of the North Pacific Ocean.

"2. That, in order to accomplish the above, and in accordance with the provisions of Article VII of the Convention, that paragraph 1, section (b) of the Annex to the Convention (as amended on May 24, 1960) be amended to read as follows:

"(b) Herring (*Clupea pallasii*)
"The Convention area off the coast of Canada in which commercial fishing for herring of Canadian origin is being or can be prosecuted.

"II. With respect to all other stocks listed in Sections 1 (a), 1 (b), 1 (c) and 2 of the Annex, no agreement was reached at this time, with respect to the conclusions from these studies, as to whether such stocks continued to qualify for abstention. The Commission therefore makes no recommendation at this time that any stocks other than the stock of herring off the coast of the United States of America south of the entrance to the Strait of Juan de Fuca no longer meet the conditions of Article IV."

The effect of the above is that the Commission will recommend to the governments of the Contracting Parties that the herring stocks off the coast of the United States south of the entrance to the Strait of Juan de Fuca should no longer be under abstention by Japan. Japan will be required to continue to abstain from fishing salmon and halibut in the eastern Bering Sea and the eastern North Pacific Ocean and from fishing herring off the coast of Canada. Canada will be required to continue to abstain from fishing salmon of United States origin in the eastern Bering Sea.

Membership of the Ad Hoc Committee on Abstention is given in the List of Participants which

forms Appendix II of this report, as is membership of the Scientific Sub-Committee of the Ad Hoc Committee on Abstention. The terms of the Convention require the Commission to review the qualifications of the stocks under abstention on an annual basis. Study of the question will be continued next year. The documents submitted to the Commission by the Contracting Parties with regard to the qualifications for abstention of the herring, halibut and salmon stocks are being published in the Commission's bulletin series.

10. Implementation of Articles III (1) (c) (i) and III (1) (c) (ii) of the Convention, with Respect to King Crab

Since 1955, scientists from Japan and the United States have conducted separate but coordinated and cooperative investigations of the king crab (*Paralithodes camtschatica*) stocks of the eastern Bering Sea. The investigation was requested in 1954 by the United States under the provisions of Articles III (1) (c) (i) and III (1) (c) (ii) of the North Pacific Convention. The purpose of these studies is to determine if joint conservation measures are required.

A sub-committee of the Committee on Biology and Research met during the 1961 Annual Meeting to consider progress in research on king crab stocks of the eastern Bering Sea and to plan for further investigations in 1962. The sub-committee noted that various reports on king crab investigations had been submitted in the past year, but was unable to examine the material in the time available, because of its complex nature.

The sub-committee on king crab noted that more complete catch statistics from the eastern Bering Sea king crab fisheries were needed. The absence of crab catch data from the U.S.S.R. fisheries in the region made analysis difficult. For this reason, the sub-committee again recommended that the Commission take appropriate action to obtain the statistics of the U.S.S.R. king crab fisheries in the eastern Bering Sea.

Members of the sub-committee concluded that their studies had not progressed to the point where they would provide a basis for recommending joint conservation measures with respect to this stock at the present time.

Preliminary plans for 1962 king crab investigations by Japan are similar to those for 1961. It is hoped that a research vessel will be available. Otherwise, the scientists will operate from the crab fishing motherships. Information will be collected on the size of crabs, catch statistics, growth, movements of tagged crabs and environmental conditions. It was uncertain whether or not the United States would have a crab research vessel in the eastern Bering Sea in 1962. If a vessel is available, the field work will follow the plans outlined for 1961. Additional emphasis will be placed on analyzing existing data with respect to migrations, changes in meat content, abundance and mortality rates.

11. Implementation of the General Provisions of the Convention

After study of Item 9 of its agenda—Consideration of salmon problems in high seas areas of intermingling—the Commission adopted the following resolution:

> " In view of the results of scientific investigations to date as contained in the reports of the Committee on Biology and Research and in accordance with the objectives of conservation of fishery resources of the North Pacific Ocean, as expressed in the International Convention for the High Seas Fisheries of the North Pacific Ocean, the Ad Hoc Committee on the Protocol recommends that the International North Pacific Fisheries Commission respectfully recommend to the Governments of the Contracting Parties that full consideration be given to the conservation needs of these fisheries resources in the area of common concern when preparing fishing regulations for future operations. Further, it is essential that special attention be given to implementation of adequate conservation regulations (patterns of fishing activities) with respect to the stocks of salmon."

12. Effect of Trawling Operations on the Halibut Stocks in the Convention Area

At the second plenary session of the 1961 Annual Meeting the Commission agreed to a proposal by the Canadian National Section that it should discuss the subject of the effect of trawling operations on the halibut stocks in the Convention area. It was subsequently decided that this subject would be dealt with by the Commission at an *in camera* session. The Chairman of the Commission reported at the final plenary session that " In spite of most extensive discussions of this topic no agreement was reached."*

13. New Officers

The Commission elected the following officers for the term beginning with the close of the Eighth

* See Section 15 of this report for the views of the national sections on this question.

Annual Meeting and terminating with the close of the Ninth Annual Meeting (1962):

Chairman of Commission
-Mr. Edward W. Allen of the United States
Vice-Chairman of the Commission
-Mr. George R. Clark of Canada
Secretary of the Commission
-Mr. Iwao Fujita of Japan
Chairman of the Committee on
Biology and Research
-Mr. Koichiro Kobayashi of Japan
Chairman of the Committee on
Finance and Administration
-Mr. Roger T. Hager of Canada.

Mr. George R. Clark of Canada will continue as chairman of the Ad Hoc Committee on Abstention and the Ad Hoc Committee on the Protocol until such time as these committees hold their next meetings.

14. Future Meetings

The first plenary session of the Ninth Annual Meeting of the Commission will be held on Monday, November 12, 1962, in Seattle, Washington. The period beginning on October 29 was designated as that within which advance committee meetings may be arranged by their respective chairmen in consultation with the Secretariat. It was recommended that, if necessary, certain sub-committees and working groups arrange to meet prior to October 29 in order to complete their work without unduly crowding the schedules of the other committees and the Commission.

15. Closing Statements

At the closing plenary session of the Eighth Annual Meeting, held on November 11, 1961, the Chairman of the Commission and spokesmen for the three national sections delivered addresses expressing their views regarding the progress and problems of the Commission. All speakers noted the increased pressure of work at the Eighth Annual Meeting and expressed appreciation for the efforts that had been made to solve the various urgent problems. Spokesmen for the visiting sections expressed appreciation for the hospitality offered by their Japanese hosts.

Commissioner Milton E. Brooding, spokesman for the United States National Section, complimented the scientists concerned with the Commission's research program for their outstanding accomplishments. Attention was drawn to the prediction that the run of sockeye to Bristol Bay in 1962 would be about nine million fish. It was the feeling of the United States Section that severe conservation restrictions should be imposed on all fisheries harvesting this run. The United States Section felt that the Commission's action in adopting the resolution quoted in Section 11 of this report did not adequately reflect the critical nature of the problem.

The United States spokesman then referred to the expansion of bottom fishing operations in the eastern Bering Sea and of the threat they would offer to the halibut resources of the eastern Pacific Ocean if they were to be extended into waters south of the Aleutian Islands. He noted that at this meeting the United States and Canadian Sections had urged the Commission to recommend that the expansion of bottom fishing operations to areas south of the Aleutians be delayed until further progress had been made in the joint study of the distribution of halibut in relation to the distribution of other bottom fish in the waters south and east of the Aleutian Islands now being made by the United States and Canada. He believed it was open to question whether the Commission had acted responsibly in this matter.

The United States Section continued to be concerned over the fact that the Commission's scientists have not had full access to the statistical and biological data being obtained in the Japanese salmon mothership fleets. Although gratified to learn that more information would be supplied in the future, it was earnestly hoped that Japan would find it possible to supply data in still greater detail as time goes on.

Commissioner George R. Clark, spokesman for the Canadian National Section expressed appreciation for many kindnesses and hospitality received during the Eighth Annual Meeting. He expressed satisfaction with progress in research and felt that solutions to some problems were coming within closer range. Referring to the subject of the effect of trawling operations on the halibut stocks in the Convention area, Mr. Clark reiterated the concern felt over the impact of large-scale trawling operations on the halibut stocks, long conserved by Canada and the United States. It was noted that the Japanese National Section had not agreed with the national sections of Canada and the United States that a resolution should be addressed to the Contracting Parties calling for no expansion or extension of trawl fishing operations south of the Aleutians until the assessment now being made of the distribution of halibut stocks is completed and the effect of trawl fishing operations on the stocks is known. The Canadian spokesman

regretted the necessity of referring to the halibut matter in such terms and expressed the hope that the Japanese Section would, in time, come to the same point of view that the Canadian Section holds on the problem.

Commissioner Masayoshi Ito, spokesman for the Japanese National Section, noted that, in spite of outstanding scientific achievements, the Commission continued to face many unsolved problems in implementation of the provisions of the Convention. He referred to the inability of the Commission to reach definite conclusions on the question of determining a line or lines which would confirm or replace the present provisional line for salmon fishing and differences of opinion as to whether the stocks listed in the Annex continued to qualify for abstention. Turning to the question of the incidental catches of halibut taken in the course of exploitation of other bottom fish stocks, Mr. Ito expressed regret that no agreement was reached on this question. Japan recognized her obligation to abstain from fishing North American halibut and recognized the successful history of joint management of the halibut stocks by the United States and Canada through the International Pacific Halibut Commission. He stated that Japan would faithfully observe the requirement to abstain from fishing for halibut. However, it was natural to undertake exploitation of other bottom fish resources, still largely unexploited. Under the present Convention, Japan had no obligation to give up the utilization of such bottom fish stocks. However, every possible measure for conservation of halibut stocks would be taken during Japan's attempts to develop the bottom fish resources. Japan was interested in the conservation of fisheries resources, had observed the provisions of the Convention faithfully up to the present time and would make further efforts in the future to cooperate with the other member countries.

APPENDIX I

LIST OF PARTICIPANTS

OFFICERS OF THE MEETING

CHAIRMAN
Iwao Fujita, Japan

VICE-CHAIRMAN
Edward W. Allen, United States

SECRETARY
George R. Clark, Canada

CANADA

Commissioners

George R. Clark,
Ottawa, Canada
John M. Buchanan,
Vancouver, B. C.
James C. Cameron,
Madeira Park, B. C.
Roger T. Hager,
Vancouver, B. C.

Experts and Advisors

A. W. H. Needler
F. Neave
J. I. Manzer
H. Godfrey
W. M. Sprules
L. Margolis
M. P. Shepard
W. E. Ricker
J. J. C. Dupuis

JAPAN

Commissioners

Iwao Fujita,
Tokyo, Japan
Yoshimitsu Ando,
Tokyo, Japan
Masayoshi Ito,
Tokyo, Japan
Koichiro Kobayashi,
Tokyo, Japan

Advisors

Tatsunosuke Takasaki
Shinkichi Katayanagi
Kenkichi Nakabe
Kyuhei Suzuki
Ganji Kawabata
Kazuyoshi Yoshii

Experts (Ministry of Foreign Affairs)

Harumi Takeuchi
Keisuke Arita
Takeshi Kanematsu
Motoo Ogiso
Kiyoshi Sumiya
Chusei Yamada
Keijiro Matsumura
Hisami Kurokochi

Experts (Fisheries Agency)

Shunichi Oguchi
Hiroaki Aikawa
Tasuku Hanaoka
Tomoyoshi Kamenaga
Masamichi Nakamura
Yoshikazu Yamanaka
Yoshihide Uchimura
Michihiko Tsukimoto
Hirotake Fujimura
Kunio Yonezawa
Koji Nakamura
Tatsuo Saruta
Tomonari Matsushita
Katsunari Ozaki
Toshiaki Otsuki
Makoto Miyake

Experts (Laboratories attached to the Fisheries Agency)

Junsuke Soeda
Nobuhiko Hanamura
Teruo Ishida
Hiroshi Kurata
Seiji Machidori
Tamotsu Yonemori
Masahisa Osako
Yoshio Fukuda
Takeyuki Doi
Toshiyuki Hirano
Shoichi Tanaka
Fukuzo Nagasaki
Seizo Sano

Experts (Hokkaido Prefectural Government)

Heihachi Kondo
Kiichi Miyaguchi

Experts (Universities)

Tomokichi Yoshihara
Ryuhei Sato
Kenichiro Kyushin

Experts (Industries)

Motosaku Fujinaga
Takeo Ito
Tojiro Shinada
Kisaburo Taguchi
Hiroshi Tominaga
Tadasu Yamamoto

UNITED STATES

Commissioners

Milton E. Brooding,
San Francisco, California

Edward W. Allen,
Seattle, Washington

John H. Clawson,
Anchorage, Alaska

Clarence F. Pautzke,
Washington, D. C.

Special Representative

Stewart L. Udall,
Secretary of the Interior

Congressional Advisor

E. L. Bartlett,
United States Senate

Experts and Advisors

C. E. Atkinson
S. Blow
F. C. Cleaver
R. A. Fredin
F. M. Fukuhara
A. C. Hartt
W. C. Herrington
D. J. Kink
D. P. Loker
J. L. McHugh
D. L. McKernan
D. Paddock
H. L. Rietze
W. F. Royce
D. Siniff
P. K. Stahnke
A. J. Suomela
H. C. Tait
W. M. Terry

Advisory Committee

C. R. Carry
H. B. Friele
DeWitt Gilbert
R. C. Kallenberg
W. Kirkness
H. E. Lokken
A. A. Owen
T. F. Sandoz
J. W. Smith
G. C. Starlund
P. Tandstad
L. Wakefield

OBSERVERS

International Pacific Salmon Fisheries Commission
C. F. Pautzke
DeWitt Gilbert

International Pacific Halibut Commission
W. M. Sprules

Inter-American Tropical Tuna Commission
J. L. McHugh

International Commission for the Northwest Atlantic Fisheries
G. R. Clark

Union of Soviet Socialist Republics
N. N. Andreev
S. S. Baranov
A. F. Suchalkin

SECRETARIAT

Permanent

R. I. Jackson
H. Kasahara
L. M. Kissack

Temporary

N. Akashi
P. Asuncion
S. Ito
M. Katsuno
R. Katsurayama
T. Konami
M. Kubotani
M. Matsueda
F. Matsumoto
M. Miyake
H. Mukai
T. Osaki
R. Oshima
K. Saito
A. Sumi
S. Taguchi
M. Ukeda

MEMBERSHIP OF COMMITTEES

1. Standing Committee on Finance and Administration

CANADA

Commissioner-member: Roger T. Hager
Commissioner-advisors: John M. Buchanan
George R. Clark

UNITED STATES

Commissioner-member: Clarence F. Pautzke
Advisor-member: D. P. Loker
Advisors: S. Blow
W. M. Terry

JAPAN

Commissioner-member: Yoshimitsu Ando
Advisors: Y. Uchimura
K. Yonezawa
C. Yamada

SECRETARIAT

Ex officio members: R. I. Jackson
H. Kasahara

2. Standing Committee on Biology and Research

CANADA

Commissioner-member: James C. Cameron
Advisor-members: A. W. H. Needler
W. M. Sprules

UNITED STATES

Commissioner-member: John H. Clawson
Advisor-members: D. L. McKernan
J. L. McHugh (alternate)
W. F. Royce

JAPAN

Commissioner-member: Koichiro Kobayashi
Advisor-members: H. Aikawa
Y. Yamanaka

SECRETARIAT

Ex officio members: R. I. Jackson
H. Kasahara

3. Ad Hoc Committee on Abstention

CANADA

Commissioner-member: George R. Clark
Commissioner-advisor: James C. Cameron
Advisors: A. W. H. Needler
W. M. Sprules
M. P. Shepard
L. Margolis
W. E. Ricker
J. J. C. Dupuis

JAPAN

Commissioner-member: Iwao Fujita
Commissioner-advisors: Masayoshi Ito
Yoshimitsu Ando
Koichiro Kobayashi
Advisors: H. Takeuchi, K. Arita, K. Sumiya, C. Yamada, S. Oguchi, T. Hanaoka, M. Nakamura, Y. Yamanaka, Y. Uchimura, K. Yonezawa, T. Matsushita, Y. Fukuda, S. Tanaka, K. Taguchi

UNITED STATES

Commisioner-member: Edward W. Allen
Commissioner-advisors: Milton E. Brooding
Clarence F. Pautzke
Advisors: C. E. Atkinson, R. A. Fredin, W. C. Herrington, R. C. Kallenberg, W. Kirkness, H. E. Lokken, J. L. McHugh, D. L. McKernan, D. Paddock, W. F. Royce, A. J. Suomela, H. C. Tait, W. M. Terry

4. Ad Hoc Committee on the Protocol

CANADA

Commissioner-member: George R. Clark
Commissioner-advisor: John M. Buchanan
Advisors: A. W. H. Needler
W. M. Sprules
M. P. Shepard
L. Margolis
W. E. Ricker
J. J. C. Dupuis

JAPAN

Commissioner-member: Masayoshi Ito
Commissioner-advisors: Iwao Fujita
Yoshimitsu Ando
Koichiro Kobayashi

Advisors: H. Takeuchi
K. Arita
K. Sumiya
C. Yamada
S. Oguchi
T. Hanaoka
T. Kamenaga
M. Nakamura
Y. Yamanaka
Y. Uchimura
K. Yonezawa
T. Matsushita
Y. Fukuda
S. Tanaka
K. Taguchi

UNITED STATES

Commissioner-member: Milton E. Brooding
Commissioner-advisor: Clarence F. Pautzke
Advisors: F. C. Cleaver
W. C. Herrington
W. Kirkness
J. L. McHugh
D. L. McKernan
W. F. Royce
A. J. Suomela
W. M. Terry

APPENDIX II

AGENDA

as adopted at the

EIGHTH ANNUAL MEETING—1961

Tokyo, Japan, November 6, 1961

1. Addresses and introductions
2. Adoption of agenda
3. Report on delegation memberships
4. Meeting procedures
   - (a) Attendance at meetings
   - (b) Schedule of sessions
   - (c) Press policy
   - (d) Minutes
5. Report of the Chairman
6. Submission of reports by the Secretariat
7. Consideration of matters of research
   - (a) Progress in research under the Protocol
   - (b) Preparation of joint reports on salmon research
   - (c) Research plans under the Protocol
   - (d) King crab research
   - (e) Statistics (Article III (1) (e))
   - (f) Other matters
8. Consideration of the need for enlarging the scope of INPFC research
9. Consideration of salmon problems in high seas areas of intermingling
10. Implementation of the Protocol
11. Implementation of Article III (1) (a) of the Convention with respect to the stocks listed in the Annex
    - (a) Halibut (Annex paragraph 1 (a))
    - (b) Herring (Annex paragraph 1 (b))
    - (c) Salmon of the northeastern North Pacific (Annex paragraph 1 (c))
    - (d) Salmon of the eastern Bering Sea (Annex paragraph 2)
12. Implementation of Article III (1) (c) (ii) with respect to king crab
13. Consideration of administrative and fiscal matters
    - (a) Accounts and audit
    - (b) Budget estimate for fiscal year beginning July 1, 1962
    - (c) Budget forecast for fiscal year beginning July 1, 1963
    - (d) Administrative report for 1961
    - (e) Comments on the form and nature of the reports submitted by Canada and the United States in 1961 under Articles III (1) (c) (iii) and X(2) of the Convention
    - (f) Publication of reports and bulletins
    - (g) Schedule of future meetings
    - (h) Other matters
14. Election of officers
15. Other business
16. Closing remarks

II. ADMINISTRATIVE REPORT FOR 1961

by Roy I. Jackson
Executive Director

1. Purpose of the Report

This report contains a factual record of actions by the Commission and the activities of its Secretariat for the period beginning with the adjournment of the Seventh Annual Meeting of the Commission on November 11, 1960, and ending on October 23, 1961, when the first committee sessions of the Eighth Annual Meeting began.

2. Officers and Staff

Officers of the Commission and its standing committees are elected for one-year terms, which begin upon adjournment of an annual meeting and continue until adjournment of the subsequent annual meeting. Representation in each of the offices rotates between Commissioners from the three member countries. Officers of the Commission for the term which began upon adjournment of the 1960 Annual Meeting were: Chairman: Mr. Iwao Fujita of Japan; Vice-Chairman: Mr. Edward W. Allen of the United States; Secretary, Mr. George R. Clark of Canada.

During this period the Chairman of the Standing Committee on Biology and Research has been Mr. James C. Cameron of Canada. The Chairman of the Standing Committee on Finance and Administration was Mr. Arnie J. Suomela of the United States, who resigned from the Commission on June 23, 1961.

Mr. George R. Clark of Canada continued as Chairman of the Ad Hoc Committee on the Protocol and the Ad Hoc Committee on Abstention. These committees do not follow the practice of rotation of chairmanship.

Permanent members of the Commission's Secretariat were the Executive Director, Roy I. Jackson; Assistant Director, Hiroshi Kasahara; Secretary, Lorraine M. Kissack.

3. Membership of the National Sections

During the period covered by this report the following were members of the various national sections: Canada; George R. Clark, John M. Buchanan, James C. Cameron and Roger T. Hager. Japan; Iwao Fujita, Yoshimitsu Ando, Kenjiro Nishimura (to September 8, 1961), Kenkichi Nakabe (to September 8, 1961), Masayoshi Ito (from September 8, 1961) and Koichiro Kobayashi (from September 8, 1961). The United States; Milton E. Brooding, Edward W. Allen, John H. Clawson, Arnie J. Suomela (to June 23, 1961) and Clarence F. Pautzke (from June 24, 1961).

4. Votes

The Rules of Procedure of the Commission provide that it may vote by correspondence when it so desires. Decisions made by the Commission in the interval between the 1960 and the 1961 Annual Meetings and the dates on which these decisions were announced or otherwise took effect are as follows:

a. The Commission approved the draft summary minutes of the Fourth and Final Plenary Session of the 1960 Annual Meeting. Approval was announced in Circular Letter No. 153, dated February 28, 1961.

b. The Commission approved the draft summary minutes of an *in camera* session which it held, during the course of the Seventh Annual Meeting, on November 11, 1960. Approval was announced in Circular Letter No. 153, dated February 28, 1961.

c. The Commission gave its approval for publication of the following documents and scientific reports:

Scientific papers on herring abstention
Six scientific papers on INPFC research
Annual Report for 1960
Scientific papers on halibut abstention
Canadian and Japanese salmon abstention papers
Japanese and United States salmon abstention papers
" Movement of salmon in the North Pacific Ocean and Bering Sea as determined by tagging, 1956-1958 "
" Intraspecific differences in the serum antigens of red salmon demonstrated by immunochemical methods "

" Use of morphological differences in determining the area of origin of red salmon (*Oncorhynchus nerka*)".

Approval for publication of these reports was announced in Circular Letters No. 162, dated June 28, 1961, and No. 168, dated August 2, 1961.

d. The Commission approved issuance of invitations to the following to be represented by observers at the 1961 Annual Meeting of the Commission and its standing committees: Food and Agriculture Organization of the United Nations, International Pacific Halibut Commission, Inter-American Tropical Tuna Commission, International Pacific Salmon Fisheries Commission, International Commission for the Northwest Atlantic Fisheries, Union of Soviet Socialist Republics.

5. Reaffirmation of Conservation Resolution

At its 1958 Annual Meeting, the Commission adopted a resolution asking the Contracting Parties to give full consideration to the conservation needs of fisheries resources in the area of common concern when preparing regulations for future operations. The text of the resolution is contained in Section 3 of the Minutes of the Third Plenary Session of the 1958 Annual Meeting. This resolution was reaffirmed by the Commission at its 1959 Annual Meeting and again at the Fourth Plenary Session of the Seventh Annual Meeting (1960). The Secretariat drew the reaffirmation of the resolution to the attention of the Contracting Parties in letters dated November 18, 1960.

6. Fiscal Matters

a. Accounts and Audit

The report of the Commission's auditors, Peat, Marwick, Mitchell & Company, for the fiscal year ended June 30, 1961, is attached to this report as Appendix I.

Each Contracting Party contributed $16,230, Canadian funds, toward the operating expenses of the Commission, making a total of $48,690 in contributions. In addition, interest earned on the working capital fund, totalling $102.59, was credited to general funds in accordance with Financial Regulation 7.1. Total of funds available was thus $48,792.59. Of this amount, the sum of $3,871.31 was held over into the 1961/62 fiscal period as a reserve for accounts payable, accrued expenses and legal obligations from the 1960/61 fiscal period. On this basis, expenditures totalled $48,792.59 and there was no surplus from the 1960/61 appropriation.

A financial bond in favour of the Commission, in the amount of $25,000, was continued on all permanent staff members. The bond is in the hands of the Deputy Minister of Fisheries for Canada for safekeeping.

b. Working Capital Fund

The Commission has a working capital fund amounting to $5,864.75, Canadian funds, which was established by equal contributions from the three Contracting Parties. No use was made of the working capital fund during the 1960/61 fiscal period.

c. Appropriations 1961/62

The Commission's budget estimate for the fiscal year beginning July 1, 1961, as approved at the 1960 Annual Meeting was transmitted to all Contracting Parties on November 18, 1960. Acceptance of the Commission's budget estimates was implicit in payment of contributions by all Contracting Parties for the first half of the fiscal year on or after July 1, 1961.

7. Reports from Contracting Parties

In 1961, for the eighth consecutive year, the United States and Canada submitted reports to the Commission as required by Articles III(1)(c)(iii) and X(2) of the Convention. These two Convention articles require Contracting Parties whose nationals continue to fish certain stocks to submit reports on their activities to the Contracting Parties whose nationals are required by the Convention to abstain from fishing the stocks. Article III(l)(c)(iii) requires regular reports on conservation measures adopted from time to time with regard to stocks of fish specified in the Annex to the Convention. Article X(2) of the Convention requires the Contracting Parties concerned to report periodically through the Commission to the Contracting Party which has agreed to abstain from the exploitation of certain stocks of fish on the enforcement conditions for their own conservation measures with respect to such stocks. The report from Canada under these articles was received by the Commission and transmitted to the other Contracting Parties on August 2, 1961. The report from the United States under these articles was received by the Commission and transmitted to the other Contracting Parties on August 15, 1961.

The Executive Director is required to study these reports each year and comment to the Commission on their form and nature. Comments on the form and nature of the reports submitted by Canada and

the United States in 1961 under Articles III(1)(c)(iii) and X(2) of the Convention have been prepared and were submitted to the Commission (INPFC Document 464).

8. Commission Publications

Since the end of June, 1961, the Commission has approved the publication, in both Japanese and English, of materials as listed in Item 4(c) of this report. At the present time, the English versions of five of these reports are being printed, and the Japanese version of one report is also in the hands of the printer. The delay in printing of Japanese versions, as compared with the English versions, has two causes. First, time is required to prepare suitable translations for the reports, most of which were originally written in English. Second, for economy in publication, the cuts or plates for the illustrations are used first in the English version and subsequently in the Japanese version. It can also properly be said that the Secretariat does not have the ability to handle this large volume of publication all at once. The budget estimate being submitted by the Secretariat for 1962/63 contains provision for increased funds to meet the costs of the Commission's increased program of publications.

At its most recent (1960) annual meeting, the Commission embarked on an ambitious program of joint reporting of the results of research on salmon on the high seas. Arrangements were made for the production of six initial, or background, volumes. Four of these chapters or volumes are being prepared by joint reporting teams of scientists from the three countries. The remaining two chapters are being prepared by the Secretariat. Progress in their preparation will be reported by the Committee on Biology and Research. The work has gone ahead in the interval between the Seventh and Eighth Annual Meetings. There has been a reasonable degree of interchange of scientists engaged in these important projects; however, it would be most beneficial to the joint reporting program if movement of scientists in both directions could be accelerated.

Contracts for printing of the Commission's publications in English and Japanese were entered in Tokyo for a one-year period which will end in April, 1962. After the annual meeting the Secretariat will do everything it can to clear up the backlog of publications in both languages.

9. Staff Activities

The Secretariat of the Commission continues to consist of three permanently-employed persons, a Director, Assistant Director and Secretary, and such temporary employees as are required and for whose employment funds are available. In general, the functions of the Secretariat include assisting the Commission at meetings, preparing agendas, budgets, reports and other documents for use at meetings, compiling statistics, preparing the annual report and other reports, and consultations and correspondence with Commissioners, scientists, and government representatives in connection with the research program and other Treaty obligations. The Secretariat acts as a clearing house for the exchange of information, samples, and scientific, technical and administrative information. In the year under review, there has been a very marked increase in the amount of material being published by the Commission. This has greatly increased the work in handling of manuscripts, negotiations with printers, authors, etc., handling of proofs and other activities in connection with the publication of scientific materials.

During the past year, the Secretariat has assembled and/or prepared a draft of the annual report of the Commission for 1960. The English-language version is at present in the hands of the printer. It will not be possible to have the printing completed in time for the Eighth Annual Meeting. Preparation of the Japanese version will follow as closely as possible after printing of the English version.

The Secretariat has compiled, reproduced and distributed a Statistical Yearbook for 1960, containing catch statistics of the important fisheries of joint interest in the Convention area. Data for the compilation were provided as usual by the statistical agencies of the member countries. Copies of the yearbook were distributed to participants in the annual meeting, and others, by mail in late September.

Early in 1961, the volume entitled " Proceedings of the Seventh Annual Meeting, 1960 " was prepared and distributed to persons designated by each national section. The Japanese language version of the 1960 Proceedings is being prepared, with the assistance and cooperation of the Japanese National Section; costs being paid by the Commission. The Proceedings of the Seventh Annual Meeting approach 300 pages, nearly double the size of the proceedings of any previous annual meeting. This increased volume has resulted in a sharp increase in cost of printing, translation, etc.

In addition to the preparation of the Proceedings

of the Seventh Annual Meeting, the Secretariat has also prepared supplementary material for inclusion in the proceedings of three other groups. The records of the Ad Hoc Committee on Abstention, the Ad Hoc Committee on the Protocol, and the *in camera* sessions of the Commission have thus been brought up to date. Japanese versions of these proceedings have also been up-dated.

Arrangements have been made in Tokyo for what might be called a translation service. In this way, preliminary translations of English documents into Japanese can be made. The translations must be checked and revised by the Secretariat. Even on this basis, the distance between the Commission's headquarters and Tokyo makes supervision and consultation on the work difficult.

The Secretariat notes with some chagrin that only one newsletter has been issued since the last annual meeting. It is intended to prepare and distribute another newsletter prior to the annual meeting--provided that information on research progress is received from all of the cooperating agencies in time.

Members of the Secretariat have done some work on their assigned chapters of the background portion of the joint comprehensive report on salmon distribution, origins and abundance. The Secretariat was assigned an introductory chapter and a chapter on historical statistics. However, the volume of other work has prevented completion of this assignment. It is our intention to distribute drafts early in 1962.

The Director visited Commissioners and others concerned with Commission affairs in Ottawa, Washington and San Francisco on two occasions in the past year. In addition, the Director and Assistant Director spent about three weeks in Japan in late April and early May. Preliminary arrangements for the annual meeting were made, contracts for printing of Japanese and English versions of Commission publications were let and arrangements were made for translations of INPFC materials. A series of discussions was held with members of the Japanese National Section on the problems of research, exchange of samples, approval of materials for publication, etc.

The Assistant Director attended the annual meeting of the International Commission for the Northwest Atlantic Fisheries in Washington in June as an observer for the Commission. On the same journey, the Assistant Director attended a conference on the economic effects of fishery regulations, which was sponsored by the Food and Agriculture Organization of the United Nations and held in Ottawa during the period from June 12 to 17, 1961.

Frequent visits have been made to the laboratories of the Bureau of Commercial Fisheries and the Fisheries Research Institute in Seattle and the Biological Station of the Fisheries Research Board of Canada at Nanaimo. The Director made a brief trip to the salmon fishing areas in the Strait of Juan de Fuca in company with Mr. Y. Uchimura of the Japanese Fisheries Agency. Arrangements for the trip were made through the courtesy of the Department of Fisheries of Canada and the Biological Station of the Fisheries Research Board of Canada.

Fisheries authorities of the Union of Soviet Socialist Republics were requested to provide information which would fill gaps in statistics of Far Eastern salmon catches which have been previously supplied to the Commission. The Commission received these data from the U.S.S.R. and also a volume of bio-statistical information on Asian salmon for the year 1960. No response was made to the request for statistical information on the catches of king crab by U.S.S.R. vessels in the eastern Bering Sea. The Commission had directed the Secretariat to make such a request, on the basis that the data were essential to the program of research on king crab being conducted jointly by Japan and the United States in the eastern Bering Sea.

APPENDIX I

PEAT, MARWICK, MITCHELL & CO.
Chartered Accountants
410 Seymour Street
Vancouver 2
British Columbia

Auditors' Report to the Commission

We have examined the statement of assets and liabilities of the International North Pacific Fisheries Commission as of June 30, 1961, and the statements of income and expenditure and receipts and disbursements for the year ended on that date and have obtained all the information and explanations we have required. Our examination included a general review of the accounting procedures and such tests of accounting records and other supporting evidence as we considered necessary in the circumstances.

In our opinion, and according to the best of our information and the explanations given to us and as shown by the books of the Commission, the accompanying statement of assets and liabilities and statements of income and expenditure and receipts and disbursements are properly drawn up so as to exhibit a true and correct view of the state of the affairs of the Commission at June 30, 1961 and the results of its operations for the year ended on that date, in accordance with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

Peat, Marwick, Mitchell & Co.
Chartered Accountants

Vancouver, B.C.
July 10, 1961

STATEMENT OF ASSETS AND LIABILITIES
June 30, 1961

Assets

General funds:			
Cash in bank			$ 3,446.31
Deposit with United Air Lines			425.00
			3,871.31
Working capital fund:			
Cash in bank			5,864.75
Equipment, at cost		$ 9,405.01	
Less accumulated depreciation		4,238.31	5,166.70
			$ 14,902.76

Liabilities

General funds:			
Accounts payable and accrued expenses			$ 3,871.31
Advances from contracting parties for working capital fund			5,864.75
Amount equivalent to expenditure on equipment, less depreciation, per contra:			
Amount at June 30, 1960		$ 9,147.68	
Additions during the year, net		257.33	
		9,405.01	
Deduct:			
Depreciation provided in previous years	$ 3,297.81		
Depreciation in current year	940.50	4,238.31	5,166.70
			$ 14,902.76

STATEMENT OF INCOME AND EXPENDITURE
Year ended June 30, 1961

Income:		
Contributions from contracting parties		$ 48,690.00
Interest earned on working capital fund bank account		102.59
		48,792.59
Expenditure:		
Personal services	$ 29,603.80	
Travel	7,933.73	
Transportation of things	114.30	
Communications	1,226.97	
Other contractual services	5,184.96	
Supplies	2,244.75	
Equipment, net	257.33	
Cost of annual meeting	2,226.75	48,792.59
		$ —

STATUS OF APPROPRIATIONS

	Budget Appropriations	*Appropriations as modified by transfers*	*Expenditures*
Personal services	$ 29,850.00	29,603.80	29,603.80
Travel	6,500.00	7,933.73	7,933.73
Transportation of things	300.00	114.30	114.30
Communications	1,200.00	1,226.97	1,226.97
Other contractual services	7,102.59	5,184.96	5,184.96
Supplies	1,500.00	2,244.75	2,244.75
Equipment	1,000.00	257.33	257.33
Cost of annual meeting	1,340.00	2,226.75	2,226.75
	$ 48,792.59	48,792.59	48,792.59

Note: The budget appropriation for " other contractual services " has been adjusted to include $102.59 received in interest on the working capital fund.

STATEMENT OF RECEIPTS AND DISBURSEMENTS
Year ended June 30, 1961

Receipts:		
Contributions from contracting parties		$ 48,690.00
Interest on working capital fund bank account		102.59
		48,792.59
Disbursements:		
Personal services	$ 29,603.80	
Travel	7,933.73	
Transportation of things	114.30	
Communications	1,226.97	
Other contractual services	4,758.49	
Supplies	2,244.75	
Equipment, net	257.33	
Cost of annual meeting	2,226.75	48,366.12
Excess of receipts over disbursements represented by increase in bank accounts:		
Balance June 30, 1961	9,311.06	
Balance June 30, 1960	8,884.59	
		$ 426.47

III. THE RESEARCH PROGRAM

A. PROGRESS IN 1961 IN CANADIAN RESEARCH ON PROBLEMS RAISED BY THE PROTOCOL

CONTENTS

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2.	Study of sockeye salmon parasites to distinguish stocks	32
3.	Study of chum salmon scales to distinguish stocks	33
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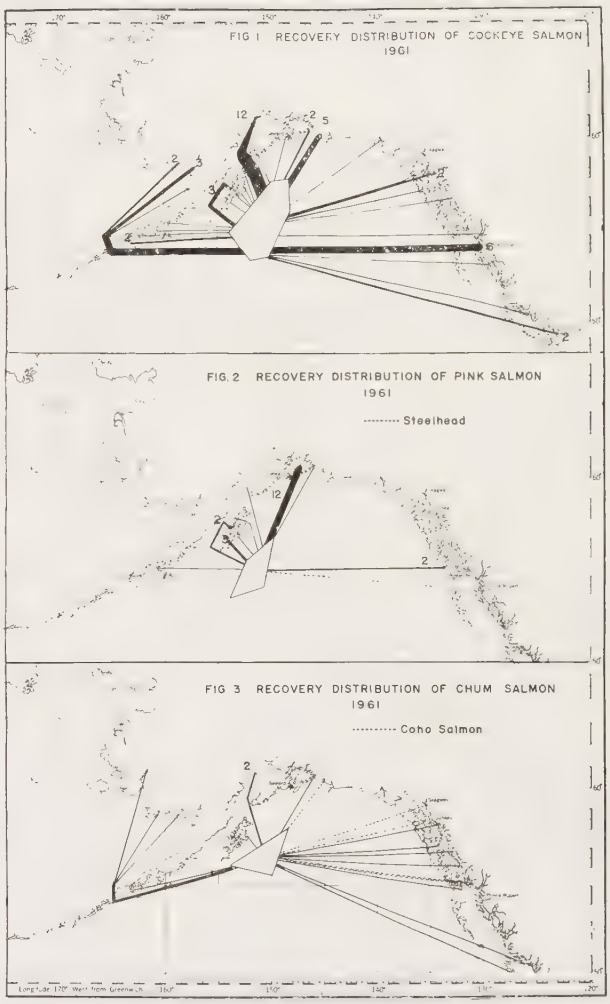
As part of the Commission's program of research on problems raised by the Protocol, Canada carried out in 1961: (1) tagging of salmon in the Gulf of Alaska, (2) study of sockeye salmon parasites to distinguish stocks and show their distribution on the high seas, (3) study of chum salmon scales for the same purpose, and (4) studies of the oceanographic conditions and circulation in the northeastern Pacific.

1. Salmon Tagging in the Gulf of Alaska

In 1961 tagging was carried out by two chartered vessels, the *Fort Ross* and the *Western Crusader*. The former fished with longlines in the western part of the Gulf of Alaska from May 29 to August 2, mainly between Latitudes 54°N. and 58°N. and between Longitudes 148°W. and 154°W. The *Western Crusader* fished with purse seines from May 23 to July 14 in waters close to the outer British Columbia coast and an adjacent part of Southeast Alaska. All recoveries of fish tagged by the *Western Crusader* were in inshore waters of British Columbia and neighbouring areas in Southeastern Alaska and are not reported here in detail.

Fishing by the *Fort Ross* was conducted by means of floating longlines under the guidance of a Japanese expert, Captain H. Nakata. The gear was fished for a relatively short period at dawn and usually comprised 20 or 30 shackles or " skates ", each carrying approximately 50 hooks baited with salted anchovy or herring. Data on the sets made and the number of tagged fish released are given in Table I.

Age determinations (Tables II and III) showed that among the sockeye, 5_2 and 5_3 fish predominated in catches made up to the beginning of July. Thereafter, 4_2 fish were the largest group and 3_2 and 4_3 made their appearance. Chums showed a similar shift in the representation of age groups, a heavy initial preponderance of 4th-year fish yielding to a steadily increasing proportion of 3rd-year fish in July. Second-year fish were taken only after mid-July.



The general pattern of recoveries of sockeye, pink, chum and coho tagged by the *Fort Ross* in the area south and east of Kodiak is shown in Figures 1 to 3.

Sockeye. From the 605 sockeye released, 58 tags (9.6%) have been returned from inshore fishing areas and spawning streams. Since some of the fish were immature a few additional recoveries are expected

in 1962. In the recovery pattern coastal areas are well represented from British Columbia to Unimak Island and Bristol Bay. Fish which subsequently travelled to northern British Columbia were still present in the tagging area on July 12; Bristol Bay fish were tagged at Longitude 152°40'W. as late as June 17.

Table I. Numbers of salmon tagged in the Gulf of Alaska, *Fort Ross*, 1961.

Date	Lat. (°N.)	Long. (°W.)	Temp. (°C.)	Skates of gear	Sockeye	Pink	Chum	Coho	Chinook	Steelhead	Total
29 May	56°52′	150°15′	8.0	20	27	—	8	—	—	—	35
3 June	56°10′	150°00′	8.0	20	12	1	16	1	—	—	30
4 June	55°35′	150°00′	8.5	19	54	1	25	—	—	—	80
6 June	53°40′	152°00′	6.8	20	17	—	2	—	—	—	19
7 June	55°20′	152°00′	7.5	20	47	—	3	—	—	—	50
8 June	55°20′	150°00′	8.5	20	16	1	8	—	—	—	25
9 June	55°20′	154°00′	8.1	20	12	1	4	—	—	—	17
10 June	56°45′	153°00′	9.0	20	—	—	15	—	—	—	15
11 June	56°10′	154°00′	8.0	20	1	3	13	—	—	—	17
12 June	57°00′	152°00′	9.8	20	—	—	—	—	—	—	—
15 June	56°50′	151°30′	9.4	10	5	1	43	1	—	1	51
16 June	56°30′	152°30′	10.0	25	9	1	31	—	—	—	41
17 June	56°10′	152°40′	9.5	25	33	4	39	—	—	—	76
18 June	56°00′	153°10′	9.5	20	2	—	5	—	—	—	7
19 June	55°20′	154°00′	10.2	20	24	—	16	—	—	—	40
20 June	53°40′	154°00′	10.0	20	1	1	2	—	—	—	4
21 June	54°30′	150°00′	10.5	20	2	3	2	—	—	—	7
22 June	56°20′	148°10′	10.8	20	23	1	7	2	—	2	35
26 June	57°00′	151°00′	11.4	20	6	6	11	3	—	—	26
28 June	58°00′	150°00′	11.4	20	1	4	7	1	1	—	14
29 June	58°05′	148°25′	12.5	20	22	26	20	14	—	1	83
30 June	57°50′	149°00′	12.8	20	—	1	7	—	—	—	8
1 July	57°05′	149°50′	11.8	20	54	24	110	4	—	—	192
9 July	57°00′	150°00′	11.4	20	11	31	26	5	—	2	75
11 July	55°52′	150°33′	12.0	20	6	38	32	5	—	2	83
12 July	55°41′	150°39′	11.4	20	11	24	25	5	—	—	65
13 July	55°22′	150°57′	11.5	20	10	32	12	5	—	—	59
14 July	55°22′	151°42′	12.2	25	15	28	18	13	—	—	74
18 July	56°52′	151°45′	11.3	10	2	7	19	—	—	—	28
20 July	54°06′	151°31′	11.1	25	36	12	17	4	—	5	74
21 July	54°03′	151°50′	11.1	30	41	6	38	1	2	3	91
22 July	53°58′	150°15′	11.4	30	24	4	32	3	—	3	66
23 July	54°21′	150°32′	11.6	30	15	23	133	5	—	3	179
24 July	55°50′	152°24′	11.8	20	15	27	49	—	—	—	91
25 July	57°00′	150°00′	12.1	30	22	33	94	5	—	2	156
26 July	56°47′	150°24′	12.2	20	13	34	50	4	—	3	104
1 Aug.	56°48′	150°23′	13.6	20	15	35	40	5	—	—	95
2 Aug.	56°32′	146°30′	14.0	20	—	3	10	1	—	—	14
3 Aug.	56°14′	142°29′	13.5	10	—	10	17	—	—	—	27
4 Aug.	55°33′	138°22′	14.0	15	—	1	—	—	—	—	1
5 Aug.	54°35′	133°57′	14.0	20	1	14	—	4	—	—	19
				Total	605	441	1,006	91	3	27	2,173

Although 11 tags (19% of the recoveries) were reported from Canadian waters, only three could be associated with the important sockeye runs to southern British Columbia. These three (one caught in the Johnstone Strait area and two found in tributaries of the lower Fraser River) were somewhat atypical for this region in that they were five years old. No recoveries were received from the Rivers Inlet and Smith Inlet fisheries which caught over a million sockeye in 1961. This suggests the possibility that

TABLE II. Ages of sockeye salmon tagged.

	Age								
	3_2	4_2	4_3	5_2	5_3	6_2	6_3	6_4	Unknown
Number	15	146	12	171	136	1	64	18	39
Percent	2.7	25.9	2.1	30.4	24.2	—	11.4	3.2	—

TABLE III. Ages of chum salmon tagged.

	Age					
	2	3	4	5	6	Unknown
Number	58	461	447	15	1	24
Percent	5.9	46.9	45.5	1.5	—	—

TABLE IV. Ranges of scale circulus counts and annulus measurements for chum samples taken in the four major regions. Percentages of the total number of observations made included within the designated limits for each of the single characters are shown for each region.

		Limits for—			
Character	Brood year	South-eastern	North-eastern	North-western	South-western
L_1 (mm. × 100)	1952	101–165	106–160	86–150	96–160
	1953	96–160	106–170	86–140	101–165
	1954	91–170	101–160	71–155	106–175
	% included	99.3%	99.2%	99.5%	99.3%
C_a (no.)	1952	10–20	10–19	8–14	11–18
	1953	10–20	10–18	8–14	12–19
	1954	10–22	9–19	8–16	12–20
	% included	99.6%	99.4%	99.0%	98.9%
C_b (no.)	1952	15–24	12–19	10–17	13–20
	1953	14–23	11–20	11–17	12–22
	1954	13–23	10–19	11–19	14–23
	% included	99.3%	99.7%	98.8%	99.1%
L_2 (mm. × 100)	1952	51–125	51–105	41–90	41–85
	1953	51–120	51–120	41–95	36–85
	1954	51–130	56–140	46–110	26–95
	% included	99.5%	99.4%	99.2%	98.8%
C_2 (no.)	1952	14–31	10–27	10–21	12–21
	1953	14–29	12–27	12–21	12–21
	1954	15–33	12–32	12–27	10–22
	% included	99.6%	99.7%	98.8%	98.5%
$L_1+10\ C_a$	1952	210–359	220–339	180–279	210–339
	1953	210–369	220–329	180–279	200–349
	1954	210–349	210–339	160–299	200–369
$L_2+10\ C_b$	1952	220–339	180–279	170–239	180–259
	1953	210–319	180–279	170–239	180–279
	1954	210–359	180–279	160–269	190–289
$0.5\ L_1/C_b$	1952	2.6–4.1	3.4–6.1	3.4–5.5	3.4–5.1
	1953	2.6–4.5	3.4–5.9	3.2–5.5	3.4–5.5
	1954	2.3–4.7	3.4–6.4	2.9–5.2	3.3–5.0

the north-south distribution of British Columbia stocks is maintained to some degree in their high-seas distribution and that the Rivers Inlet and Fraser River sockeye in the Gulf of Alaska in 1961 were mainly south of Latitude 54°N.

Pink. The 26 pink salmon recovered represent about 6% of those tagged. The recovery areas extended from Southeast Alaska (Noyes Island) to the Alaska Peninsula, with a majority of the fish reported from Prince William Sound.

Chum. Only 15 tags (1.5%) have been returned. This low recovery rate can be explained only partly by the fact that many (probably about half) of the fish tagged were immature. The recovered fish showed wide distribution, from Vancouver Island to the Kuskokwim River, which enters the Bering Sea at Latitude 60°N. With the exception of one 3rd-year fish from Southeast Alaska all the recovered chums were 4th-year individuals.

Coho. Five cohoes, representing 5.5% of the fish tagged, were recovered at Alaskan localities, from the Martin River (near Dixon Entrance) to the Copper River in Central Alaska.

Steelhead. One fish, from 27 tagged, was recovered in the Skeena River.

It is evident that there was much intermingling in the tagging area of stocks from many coastal areas. The closeness of this intermingling was shown by frequent instances in which fish caught in the same set subsequently migrated long distances in quite different (sometimes opposite) directions. This was true alike of sockeyes, pinks and chums.

2. Study of Sockeye Salmon Parasites to Distinguish Stocks

The parasites of pink and sockeye salmon have been thoroughly studied to determine their usefulness in distinguishing the geographical origin of fish of these species caught on the high seas. In the case of pink salmon the results were not promising and work on this species was discontinued after examination of samples collected in 1955, 1956 and 1957. Significant findings were achieved with sockeye salmon and sampling was continued until 1959 when the most numerous and best-distributed collections were made. In 1961 the results of examination of samples of sockeye collected in the years 1955 to 1959 were brought together in a report submitted to the Commission for publication, thus concluding this phase of the work.

The survey of the parasites (mainly metazoan) of sockeye salmon, both in the freshwater and marine environments, yielded more than 50 species, of which two of freshwater origin, larval *Triaenophorus crassus* (Cestoda) in the muscle and *Dacnitis truttae* (Nematoda) in the intestine, proved to be useful indicators of the geographic origin of sockeye captured at sea. These two parasites have a limited distribution in sockeye stocks in their freshwater areas of origin and apparently live as long as their host. *T. crassus* is found only in stocks originating in Western Alaska (essentially Bristol Bay) and *D. truttae* is known only from some sockeye from Kamchatka. Because *T. crassus* apparently is more common in Bristol Bay sockeye than is *D. truttae* in Kamchatka sockeye, the former parasite is more useful in establishing the ocean distribution of Bristol Bay sockeye than is the latter in determining the ocean distribution of Kamchatkan sockeye. No distinctive parasite tag was found in any of the North American stocks originating in rivers tributary to the Gulf of Alaska and the northeast Pacific.

Two trematodes acquired at sea, *Hemiurus levinseni* and *Tubulovesicula lindbergi*, may be useful in delimiting the general oceanic areas occupied by Asian and North American sockeye but a lack of knowledge regarding their life span in sockeye precludes arriving at any definite conclusions at this time.

During the years 1955 to 1959, 12,888 sockeye were examined. These consisted of 1,853 seaward migrants from 24 North American localities, 2,507 adults from 37 North American river systems or coastal areas, 144 adults from two U.S.S.R. (Kamchatka) rivers, 92 juveniles from British Columbia coastal waters and 8,292 specimens (approximately 62% maturing and 38% immature) from the high seas. The high-seas specimens were collected almost entirely from May through August from many stations across the North Pacific and the Bering Sea and from the Okhotsk Sea off the southwest coast of Kamchatka. Most of the maturing sockeye were taken in May and June and most of the immatures in July and August. The general lack of samples from U.S.S.R. rivers was partially offset by samples of maturing sockeye from the Sea of Okhotsk and from close to the east coast of Kamchatka.

Maturing Bristol Bay sockeye (i.e., infected with *T. crassus*) were found between Latitudes 50°10′N. and 59°N. westward to 171°E. in the Bering Sea and to 168°15′E. in the North Pacific Ocean and eastward to 145°W. in the northern part of the Gulf of Alaska. Immature Bristol Bay sockeye were found between Latitudes 49°N. and 60°N. from 145°W. to 175°E.

in the North Pacific and between 175°W. and 170°E. in the Bering Sea. Maturing sockeye of Kamchatkan origin (i.e., infected with *D. truttae*) were found in the Sea of Okhotsk and from the east coast of Kamchatka eastward to 173°19'E. in the North Pacific and to 175°E. in the Bering Sea at latitudes varying from 47°30'N. to 58°N. Immature Kamchatkan sockeye were found from the east coast of Kamchatka eastward to 169°56'W. in the North Pacific and to 175°W. in the Bering Sea, between 48°N. and 58°N. Because the majority of sockeye originating in Bristol Bay and Kamchatka do not carry a parasite identifying their area of origin and because of certain limitations in the sampling, stocks from these two regions may extend over a wider oceanic range than noted above.

Based on rates of *Triaenophorus* infection, maturing Bristol Bay sockeye comprised a very large proportion of the samples taken in June in the eastern Bering Sea (at least to 175°W. in 1957, to 170°W. in 1958 and to 180° in 1959); they predominated in the samples from immediately south of the Aleutians from 169° 39'W. to 175°E. in late May and early June, 1959, and they comprised a large proportion of the samples taken at 55°N., 155°W. in the Gulf of Alaska in the first half of June (in 1958 and 1959). In the northern part of the Gulf of Alaska in late May and the first half of June the proportion of maturing Bristol Bay sockeye diminished towards the east; at 141°W., in 1959, they were absent or scarce. This decrease in the proportion of Bristol Bay sockeye was probably due to the presence of sockeye having originated in the rivers tributary to the Gulf of Alaska and northeast Pacific. In the northwest Pacific from 175°E. to the east coast of Kamchatka maturing Bristol Bay sockeye were very scarce or absent in all years. It appears that the sockeye in this region were principally of Kamchatkan origin. Samples of maturing sockeye from the western Bering Sea in May or June generally were scanty, but at 171°E. in 1959 Bristol Bay sockeye formed a minor proportion of the samples and in 1958 between 166°E. and 169°E., close to the northwest coast of Kamchatka, they appeared to be absent. The predominant group of sockeye in these samples had probably originated in Kamchatkan rivers.

3. Study of Chum Salmon Scales to Distinguish Stocks

Studies of the scale characters of chum salmon from various coastal areas throughout the North

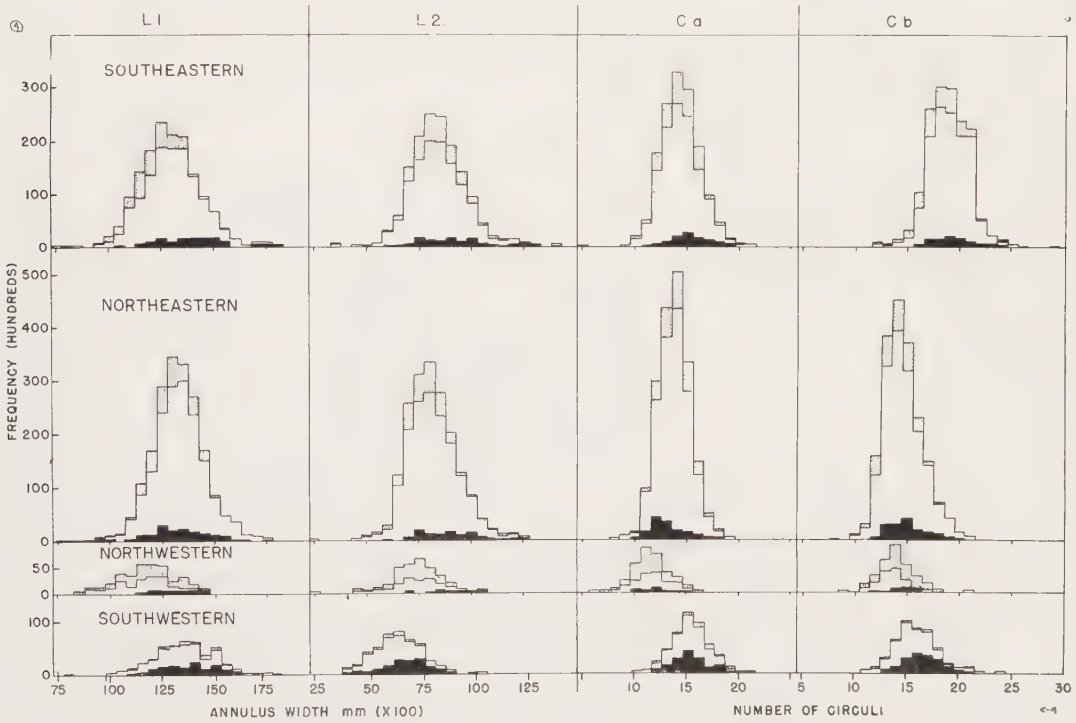


Figure 4. Annulus widths in the first and second years, and circulus counts in the first and last halves of the first year for scales of chums of the 1953 brood year from different areas of the North Pacific. L_1—annulus width of the first year band. L_2—annulus width of the second year band. C_a—circuli in the first half of the first year. C_b—circuli in the last half of the first year. Black bars indicate frequencies for 3_1 fish, white for 4_1's and cross-hatched for 5_1's.

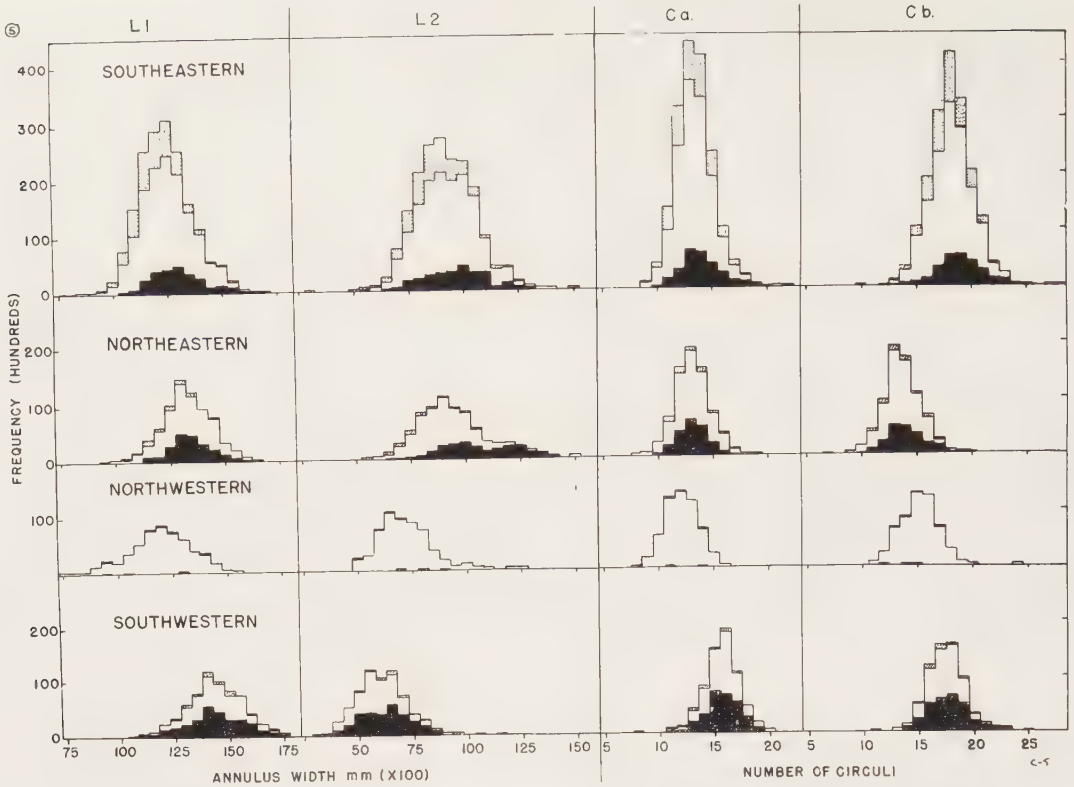


FIGURE 5. Annulus widths in the first and second years, and circulus counts in the first and last halves of the first year for scales of chums of the 1954 brood year from different areas of the North Pacific. L_1—annulus width of the first year band. L_2 –annulus width of the second year band. C_a—circuli in the first half of the first year. C_b—circuli in the last half of the first year. Black bars indicate frequencies for 3_1 fish, white for 4_1's and cross-hatched for 5_1's.

Pacific area and on the high seas were continued in 1961. Previous reports have been concerned only with coastal samples for the years 1956 to 1958 and with high-seas samples of 4– and 5–year-old fish collected in 1956 and 1957. The present study incorporates data for coastal samples taken in 1959 and for 3–year-olds taken on the high seas in 1956 and 1957. Counts of circuli and annulus measurements are now available for fish of all ages from the brood years 1952, 1953 and 1954. In Figures 4 and 5, data for the latter two brood years are shown. As described in earlier reports, fish originating in the streams of British Columbia (Canada) and the State of Washington (United States) had many closely packed circuli and large annulus widths, whereas those from Central and Western Alaska and along the North American shores of the Bering Sea and Arctic Ocean had fewer and more sparsely spaced circuli but about the same annulus widths as those from the more southerly parts of North America. Those from Siberia in the U.S.S.R. had the smallest circulus counts and annulus widths of all. Southward to Hokkaido, Japan, circulus counts and annulus widths increased again. Second-year band circulus counts and annulus measurements were quite similar throughout North America. Second-year measurements for stocks of the U.S.S.R. and Japan were similar to each other, and tended to be significantly smaller than those for North American fish. In 1958 scales from chums originating in the Amur River region of the U.S.S.R. were obtained for the first time. These proved to have characteristics intermediate between those of the more northerly U.S.S.R. runs and those of Japan (see Fig. 6), but their scale pattern tended more towards the northern U.S.S.R. than the Japanese type. For both brood years, for chums from all areas, there was a tendency for 5–year-olds to exhibit smaller annulus measurements (in both the first and second year bands) than 4–year-olds, which in turn exhibited smaller measurements than 3–year-olds. This suggests an association between growth and age of return with larger fish tending to mature at a younger age.

In Table IV, for fish of all ages from each of four general regions (Southeastern Region—including the

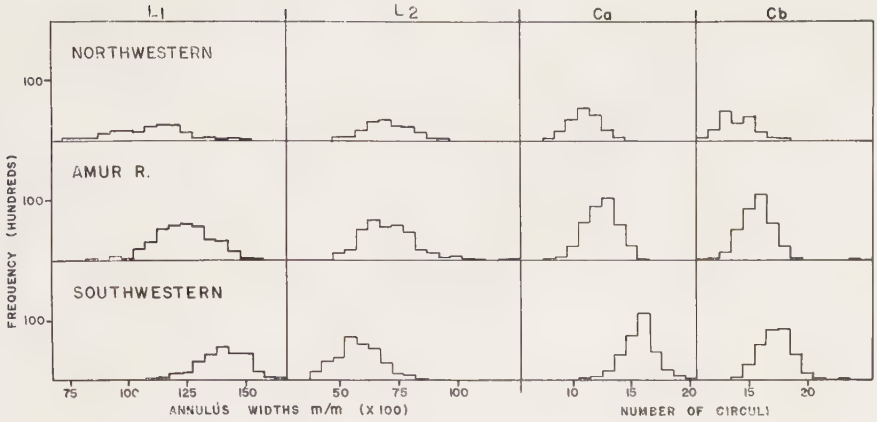


FIGURE 6. Comparison of scale characteristics of chum salmon from the Northwestern Region, the Amur River and the Southwestern Region.

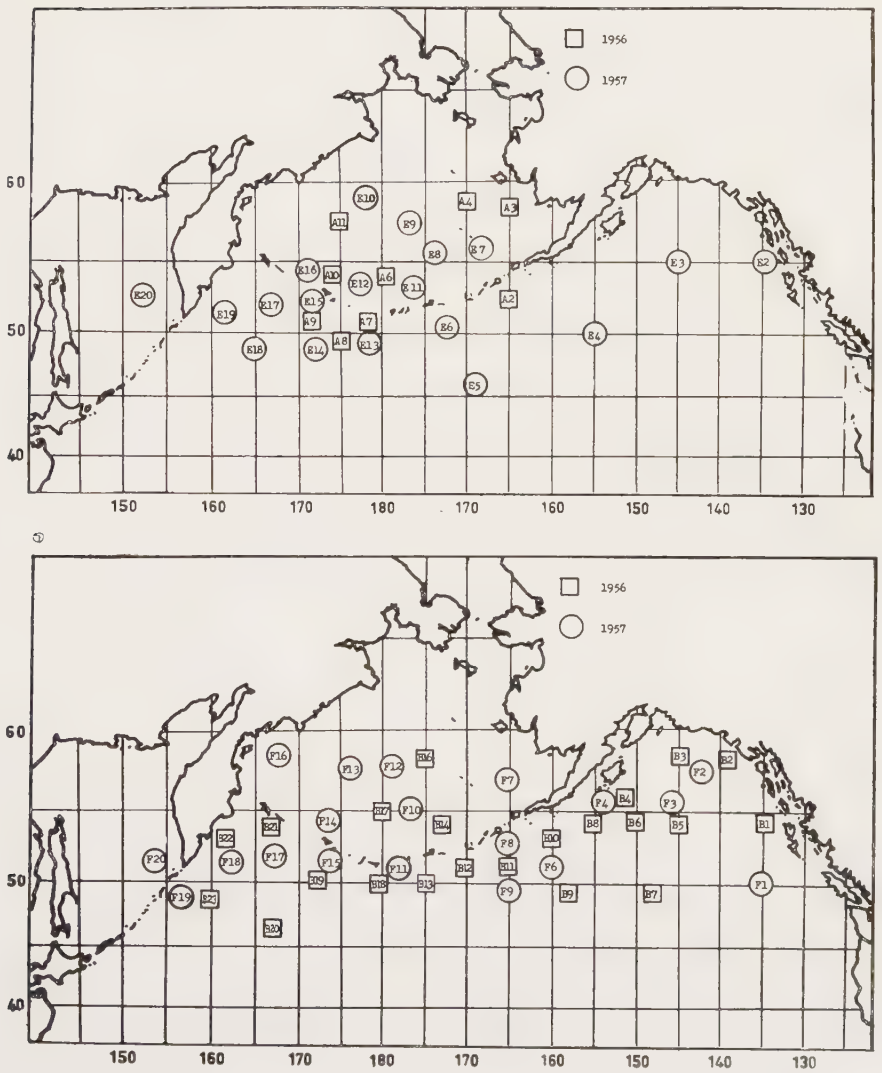


FIGURE 7. Sampling areas for 3-year-olds taken in May and June (upper figure) and from July to September (lower figure) in 1956 and 1957.

States of Washington and Oregon in the United States, British Columbia in Canada and Southeastern Alaska as far north as the Taku River; Northeastern Region—Central, Western and Northern Alaska; Northwestern Region—the U.S.S.R.; Southwestern Region—Hokkaido and Honshu in Japan), the ranges of measurements and counts for various characteristics are shown. The ranges were determined as described in last year's (1960) report. The data indicate that variations in measurements and counts did not vary greatly from brood year to brood year.

By comparing the scale characters of individual chums taken on the high seas with the ranges derived in Table IV, attempts were made to identify the origin (by region) of 3–year-old chums sampled on the high seas in 1956 and 1957. The results are summarized in Tables V to VIII. Sampling areas indicated in the tables are shown in Figure 7.

In general, the results of examination of the scales of 3–year-olds parallel those for 4– and 5–year-olds described in last year's (1960) report. In Figures 8 to 10, data for all three age classes are combined for the years 1956 and 1957. Briefly the results indicate the following distribution patterns.

(a) *Apparent high-seas distribution of Asian chums.* During May and June chums with scale patterns similar to those sampled in northern U.S.S.R. coastal areas were well represented in most samples taken westward from 175°W. (see Fig. 8). Some samples taken further east, including several taken in the Gulf of Alaska, also contained substantial proportions of " Northwestern " fish. The appearance of such fish in samples of mature fish taken immediately offshore from the coast of British Columbia (10% of the fish sampled early in the season in the vicinity of 135°N., 55°W. were mature fish designated as originating in the Northwestern Region) indicates the probability of considerable error in the methods. Because these fish were maturing, the possibility that they were truly Asian fish bound for rivers some 5,000 miles distant within a period of no more than three months must be discounted. It is more likely that they were North American fish of a type not well represented in the North American coastal standards. Despite this apparent source of error, contrasts in the proportions of fish of " Northwestern type " in different areas provides a reasonable picture of the distribution of northern U.S.S.R. stocks in the mid-ocean area. During May and June most chums sampled westward from 175°W. in both the Bering Sea and North Pacific Ocean contained 20% or more of the Northwestern type and very few of any other (see Figs. 9 and 10). Samples immediately to the eastward contained less than 10% of Northwestern and larger proportions of fish of North American types, suggesting a rather sharp division between areas occupied mainly by fish originating in the northern U.S.S.R. and those from other areas. At

Table V. Numbers of chum salmon from various high-seas areas designated as originating in the four major coastal regions and, more generally, in North America and Asia—3-year-olds sampled *early in 1956* (May and June).

Sampling area	Month	Designated region of origin: Southeastern	Northeastern	Total[1] North America	Northwestern	Southwestern	Total[2] Asia	Total[3] Unidentified	Total
A 1	June	0	0	0	0	0	0	0	0
A 2	May	0	0	0	0	0	0	0	0
A 3	June	0	0	0	0	0	0	0	0
A 4	June	0	0	0	0	0	0	0	0
A 5	June	0	0	0	0	0	0	0	0
A 6	June	0	1	1	1	0	1	2	4
A 7	June	0	0	0	1	0	1	1	2
A 8	May	0	0	0	3	0	3	4	7
	June	0	0	0	11	1	13	10	23
A 9	June	0	0	1	12	0	13	16	30
A 10	June	0	0	0	0	0	1	2	3
A 11	June	0	0	0	1	0	1	1	2
Total		0	1	2	29	1	33	36	71

[1] Includes fish designated as originating in the Southeastern and Northeastern Regions specifically as well as those for which it was possible only to designate the continent of origin.

[2] Includes fish designated as originating in the Southwestern and Northwestern Regions as well as those for which it was possible only to designate the continent of origin.

[3] Total number of fish for which neither the precise region nor continent of origin could be designated.

TABLE VI. Numbers of chums from various high-seas areas designated as originating in the four major coastal regions and, more generally, in North America and Asia—3-year-olds sampled *late in 1956* (July to September).

Sampling area	Month	Designated region of origin							
		South-eastern	North-eastern	TOTAL[1] NORTH AMERICA	North-western	South-western	TOTAL[2] ASIA	TOTAL[3] UNIDENTIFIED	TOTAL
B 1	July	2	0	2	0	0	1	8	11
	Aug.	13	3	16	1	0	1	2	19
B 2	July	14	1	19	3	0	3	9	31
B 3	July	22	1	37	0	1	1	27	65
	Aug.	1	3	9	0	0	0	14	23
B 4	July	0	0	0	0	0	0	1	1
	Aug.	1	2	3	1	0	1	5	9
B 5	July	18	28	66	15	0	18	146	230
	Aug.	8	10	26	1	1	2	25	53
B 6	July	4	11	18	2	0	2	58	78
	Aug.	10	13	32	2	2	4	66	102
	Sept.	4	12	21	0	2	0	21	42
B 7	July	9	51	74	6	0	9	80	163
	Sept.	0	0	1	0	0	0	0	1
B 8	July	14	2	24	2	0	4	31	59
	Aug.	21	8	39	2	0	2	47	88
B 9	July	0	4	6	0	0	0	5	11
	Aug.	2	8	14	1	0	2	21	37
	Sept.	1	0	1	0	0	0	0	1
B 10	Aug.	17	8	37	0	1	1	60	98
B 11	Aug.	11	5	19	1	0	1	34	54
	Sept.	15	4	25	9	0	9	32	66
B 12	July	0	0	0	0	0	0	0	0
	Aug.	2	2	5	0	0	0	8	13
	Sept.	2	0	2	0	0	0	10	12
B 13	Aug.	0	1	2	2	0	2	6	10
B 14	July	0	0	0	0	0	0	0	0
	Aug.	0	1	1	0	0	1	14	16
B 15	Aug.	0	0	0	0	0	0	1	1
B 16	July	2	1	3	1	0	1	10	14
B 17	July	0	2	5	9	0	11	40	56
B 18	Aug.	1	0	2	1	0	1	8	11
	Sept.	2	1	3	0	0	0	1	4
B 19	July	0	0	1	0	0	0	6	7
	Aug.	4	0	6	3	0	3	17	26
B 20	July	0	1	3	8	0	8	60	71
B 21	July	0	0	0	0	0	0	5	5
	Aug.	0	0	2	10	0	10	26	38
B 22	July	0	0	0	1	0	1	1	2
	Aug.	0	0	0	0	0	0	0	0
B 23	Aug.	0	0	1	0	0	0	4	5
TOTAL		200	183	525	81	7	99	909	1,533

[1] Includes fish designated as originating in the Southeastern and Northeastern Regions specifically as well as those for which it was possible only to designate the continent of origin.

[2] Includes fish designated as originating in the Southwestern and Northwestern Regions as well as those for which it was possible only to designate the continent of origin.

[3] Total number of fish for which neither the precise region nor continent of origin could be designated.

TABLE VII. Numbers of chums from various high-seas areas designated as originating in the four major coastal regions and, more generally, in North America and Asia—3-year-olds sampled *early in 1957* (May and June).

Sampling area	Month	Designated region of origin							
		South-eastern	North-eastern	Total[1] North America	North-western	South-western	Total[2] Asia	Total[3] Unidentified	Total
E 1	May	0	0	1	1	0	1	2	4
	June	0	0	0	1	0	1	0	1
E 2	May	2	1	3	0	0	0	1	4
	June	19	3	24	11	0	11	83	118
E 3	June	3	6	11	16	0	16	103	130
E 4	June	0	1	1	4	0	4	8	13
E 5	May	0	1	1	0	0	0	11	12
E 6	June	0	2	2	0	0	9	37	48
E 7	June	0	5	5	0	0	0	4	9
E 8	June	1	0	1	6	0	6	47	54
E 9	June	0	1	1	2	0	2	12	15
E 10	June	0	0	0	1	0	1	8	9
E 11	June	0	0	0	0	0	1	6	7
E 12	June	1	0	1	2	2	4	49	54
E 13	June	0	0	0	1	0	2	22	24
E 14	May	0	0	1	0	0	0	7	8
	June	0	0	0	3	0	3	39	42
E 15	June	0	0	0	6	0	6	9	15
E 16	June	1	0	1	0	2	2	24	27
E 17	May	0	1	1	6	0	6	30	37
	June	0	1	1	4	0	4	11	16
E 18	May	0	3	0	10	0	11	50	61
	June	0	0	0	1	0	1	0	1
E 19	June	0	0	0	3	0	3	8	11
E 20	June	0	0	0	1	0	0	2	2
TOTAL		27	25	55	79	4	94	573	722

[1] Includes fish designated as originating in the Southeastern and Northeastern Regions specifically as well as those for which it was possible only to designate the continent of origin.

[2] Includes fish designated as originating in the Southwestern and Northwestern Regions as well as those for which it was possible only to designate the continent of origin.

[3] Total number of fish for which neither the precise region nor continent of origin could be designated.

this time of year most of the fish sampled, especially closer to the coastline, were maturing fish.

Late in the season (July to September—see Fig. 8) sampling was more widespread and included a good coverage of the Gulf of Alaska as well as of the western part of the study area. As the season progressed it would be expected that mature chums destined to spawn during the summer months would emigrate rapidly from the high seas, leaving behind immature fish and populations of later spawning fish. The stocks of northern Asia are summer spawners and their distribution pattern, as indicated by the scale studies, reflects their movement away from the central Bering Sea toward the Asian coast. The proportions of identifiable Northwestern chums were very high along the Kamchatka coast (about the same as in the early season) and considerably lower than they had been in the spring almost everywhere else. Samples throughout most of the western North Pacific and Bering Sea contained moderate proportions of Northwestern fish and large proportions of unidentifiable fish, suggesting that the residual populations there could be made up of a high proportion of late spawning southern Asian fish, which are impossible to identify because of their intermediate scale characters.

The representation of so-called Northwestern fish in the Gulf of Alaska both early and late in the sampling season may be attributable to error as suggested above. However, it is worthy of note that (with the exception of the early season samples taken off the British Columbia coast) of 151 fish sampled

TABLE VIII. Numbers of chums from various high-seas areas designated as originating in the four major coastal regions and, more generally, in North America and Asia—3-year-olds sampled *late in 1957* (July to September).

Sampling area	Month	Designated region of origin							
		South-eastern	North-eastern	Total[1] North America	North-western	South-western	Total[2] Asia	Total[3] Unidentified	Total
F 1	July	0	0	0	0	0	0	13	13
	Aug.	0	1	3	0	0	0	2	5
F 2	July	13	5	19	34	0	34	92	145
	Aug.	9	4	15	4	1	6	36	57
	Sept.	2	0	2	0	0	0	4	6
F 3	July	1	2	3	0	0	0	10	13
	Aug.	0	2	3	0	0	0	9	12
F 4	July	3	4	9	37	0	37	59	105
	Aug.	8	5	15	16	0	16	41	72
F 5	July	0	0	0	0	0	0	0	0
F 6	July	5	8	14	1	0	3	49	66
F 7	July	0	3	3	1	0	1	11	15
F 8	July	23	15	43	7	1	9	132	184
	Aug.	15	15	34	5	0	5	125	164
F 9	July	1	1	5	4	1	6	36	47
	Aug.	6	9	19	1	0	4	91	114
F 10	July	5	0	5	1	0	4	23	32
	Aug.	1	0	1	3	1	4	64	69
F 11	July	3	3	7	4	1	10	162	179
	Aug.	19	10	32	10	1	15	205	252
F 12	July	0	0	1	2	0	4	28	33
F 13	July	0	1	1	2	1	5	38	44
	Aug.	0	0	0	0	0	1	5	6
F 14	July	0	2	3	2	1	6	32	41
	Aug.	0	0	0	6	3	12	112	124
	Sept.	0	1	1	0	0	0	8	9
F 15	July	0	1	1	1	0	1	24	26
	Aug.	6	1	8	1	1	4	46	58
F 16	July	1	0	1	5	0	5	16	22
F 17	July	0	0	0	8	0	8	58	66
	Aug.	0	0	0	1	0	1	13	14
F 18	July	0	3	3	3	1	5	72	80
	Aug.	0	0	0	1	1	2	7	9
F 19	July	0	0	1	1	0	1	3	5
F 20	July	0	0	0	3	0	3	10	13
Total		121	96	252	164	14	212	1,636	2,100

[1] Includes fish designated as originating in the Southeastern and Northeastern Regions specifically as well as those for which it was possible only to designate the continent of origin.

[2] Includes fish designated as originating in the Southwestern and Northwestern Regions as well as those for which it was possible only to designate the continent of origin.

[3] Total number of fish for which neither the precise region nor continent of origin could be designated.

eastward from 160°W. designated as originating in the Northwestern Region all but five were immatures. Because these immature fish still had from eight months to several more years of ocean life before returning to their spawning grounds, it is possible that at least some were truly Asian fish and not misclassified fish of North American origin.

(b) *Apparent high-seas distribution of North American chums.* During May and June fish designated as originating in Central and Western Alaska (the "Northeastern Region") were best represented (about 25%) in samples taken in the east Bering Sea (eastward from 170°W.) and south of the Aleutians near 165°W. (Fig. 9). A few were also found in the

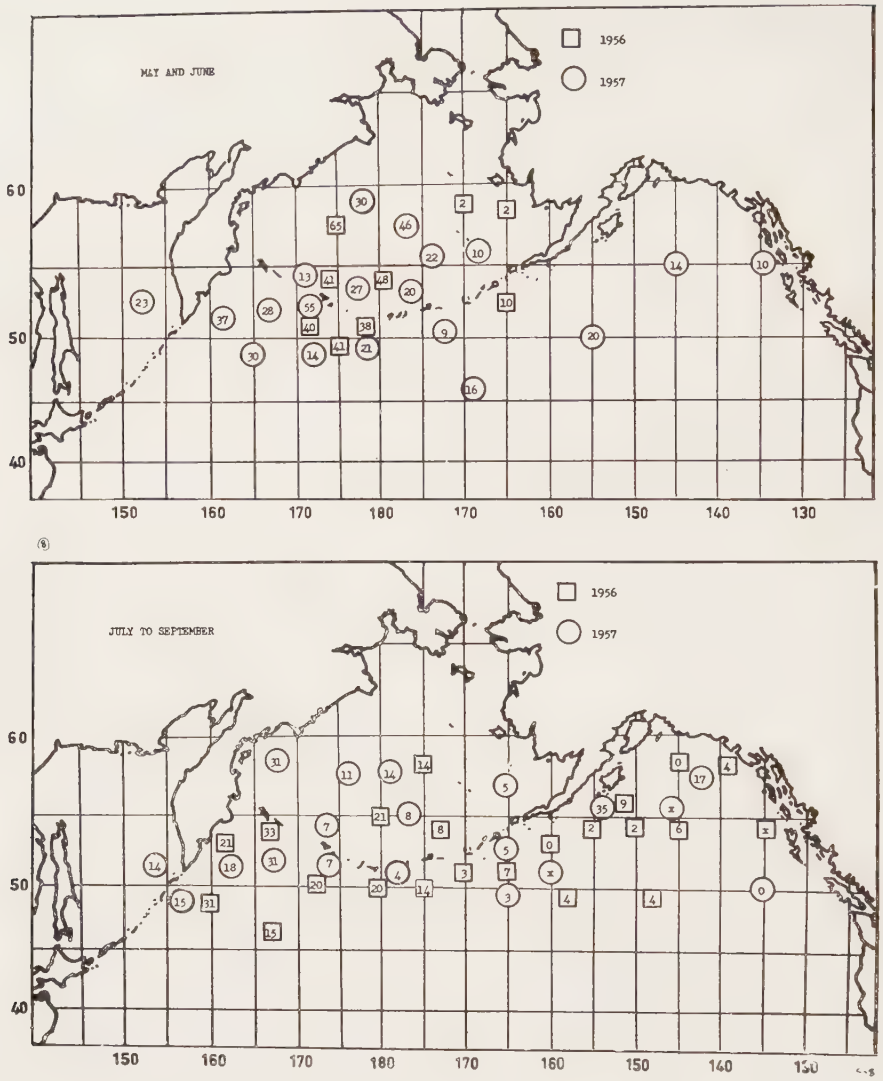


FIGURE 8. Percentage contribution of chums (age 3 to 5) designated as originating in the "Northwestern Region" (northern U.S.S.R.) in the early and late parts of the years 1956 and 1957.

mid-ocean area between 175°E. and 180°. Early season sampling in the Gulf of Alaska was very sparse; fish designated as originating in the Southeastern Alaska-British Columbia area ("Southeastern Region") were found in concentration only in the large samples taken immediately off the British Columbia coast (Fig. 10).

In the late part of the season (July to September) identifiable northern Alaskan fish appeared in greatest proportions in samples in the east Bering Sea and in the North Pacific between 155°W. and 175°W. They also contributed significantly to samples taken throughout the western Gulf of Alaska. Mature fish of Southeastern origin were concentrated (in one case as high as 47% of the sample) against the eastern shore of the Gulf, but also occurred in smaller proportions (from 4 to 19%) along the northern rim of the Gulf westward to about 170°E.

4. Oceanography

(a) *Oceanographic observations in* 1961. The program of oceanographic surveys, observations, and data assembly in 1961 included the following:

i. Two-ship survey of northeastern Pacific, May 16–July 1. This was a departure from the program of previous years when there was a mid-winter (January–March) and a mid-summer (July–August) survey. This year, only one survey was carried out

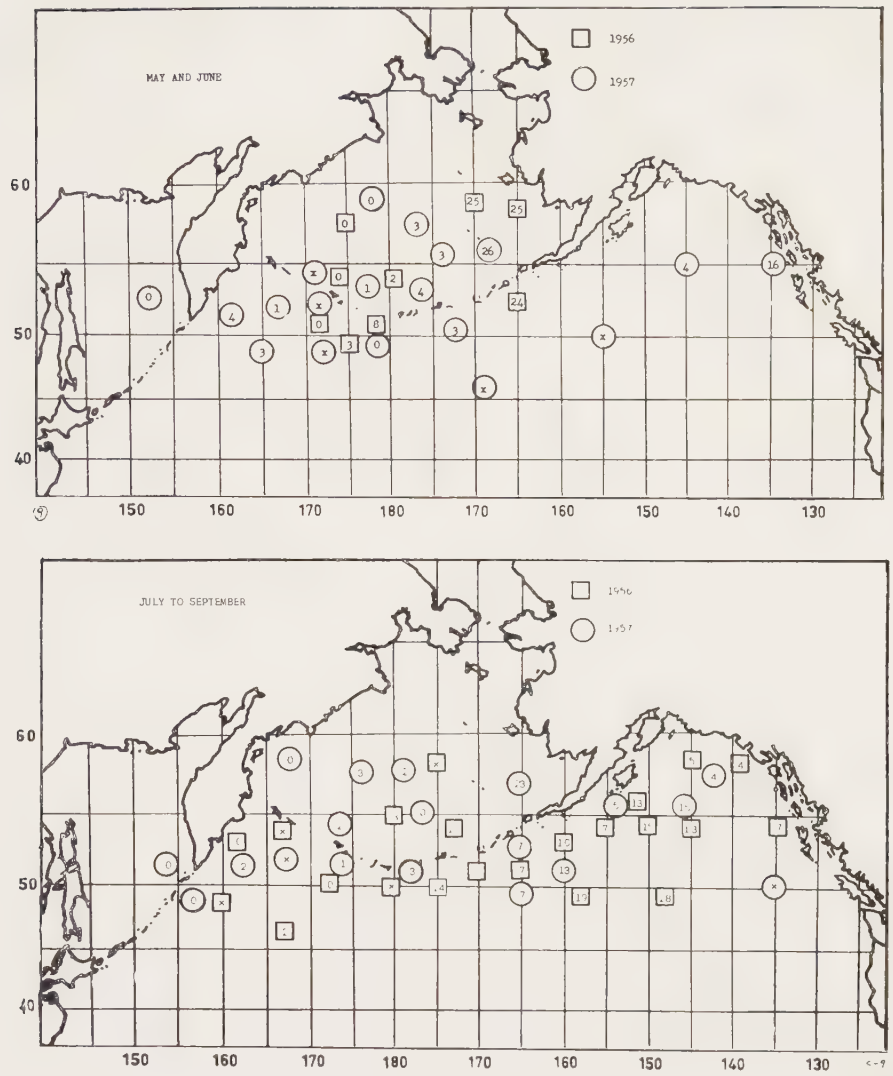


FIGURE 9. Percentage contribution of chums (age 3 to 5) designated as originating in the "Northeastern Region" (Central and Western Alaska) in the early and late parts of the years 1956 and 1957.

during the early summer period. On the basis of previous work (1955–1960) it is considered that the timing and coverage of this 1961 survey is an adequate monitor of the waters below the seasonal zone and that the previous winter conditions in this zone (0 to 100 metres depth) are easily recognized in these data. Also, it provides reference data in time for the prediction of late summer oceanographic conditions in the area.

Two vessels, C.N.A.V. *Oshawa* and C.N.A.V. *St. Anthony*, occupied 213 stations (Fig. 11). On the continental shelf, observations of temperature, salinity and dissolved oxygen were made to near the bottom. In the oceanic regions, the observations were made to 1,200 metres depth, except at the special stations where samples were obtained to the bottom or 4,000 metres depth, whichever was the least. Bathythermograph, secchi disc, and plankton observations were also made throughout the area.

ii. Oceanographic observations at Ocean Station "P" (Lat. 50°N., Long. 145°W.). Four patrols were made in alternate six-week periods aboard C.M.S. *St. Catharines*. Oceanographic observations were similar to those made in previous years. In addition, detailed studies of primary productivity were made.

iii. Regular monitor of a line of six stations between Ocean Station "P" and the coast. Every

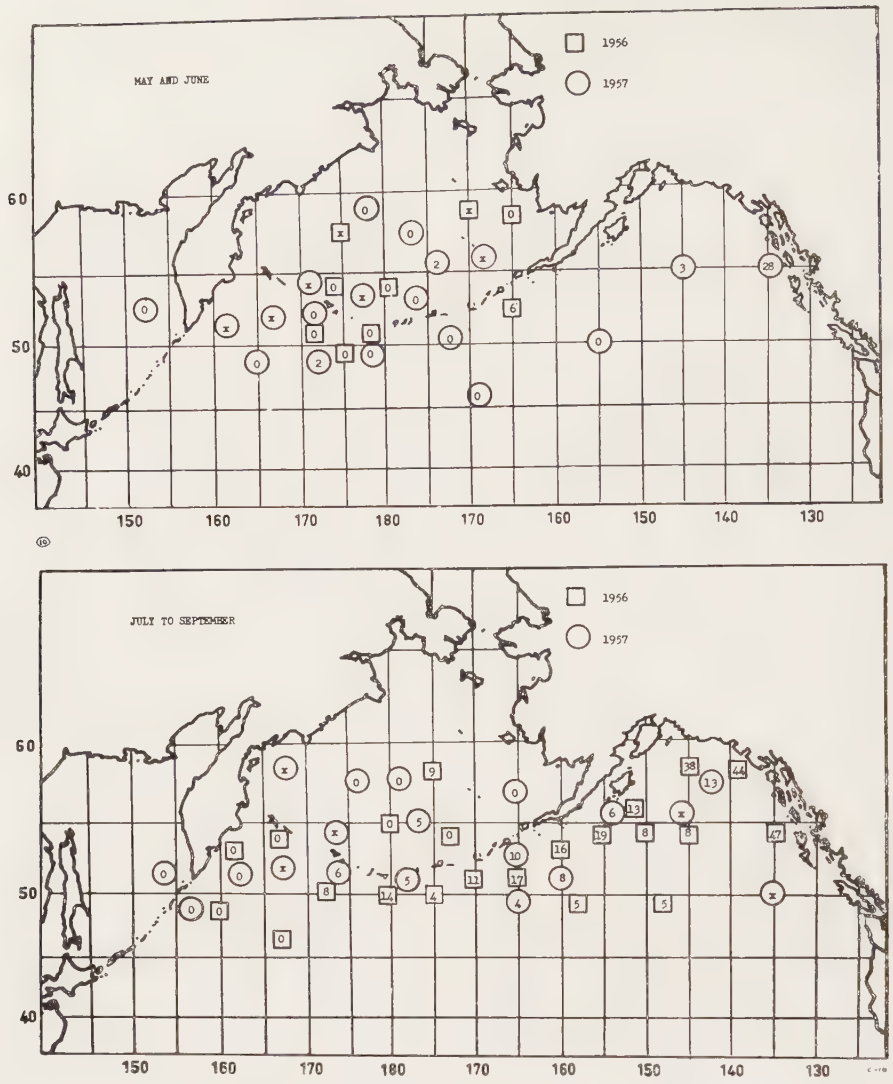


FIGURE 10. Percentage contribution of chums (age 3 to 5) designated as originating in the "Southeastern Region" (British Columbia-Southeastern Alaska) in the early and late parts of the years 1956 and 1957.

six weeks observations were made from C.M.S. *St. Catharines* en route to and from Ocean Station "P". These were supplemented by observations provided by special cruises or incorporated with other programs in the area so that this line was observed every three weeks.

iv. Regular monitor of stations on and immediately off the continental shelf.

v. Daily seawater observations. Daily observations of surface seawater temperatures and salinity were continued at 14 positions along the Canadian coast.

vi. Productivity cruise. A two-week cruise to observe standing crop of phytoplankton, rate of production, and dissolved nutrient and respiratory factors was made in the oceanic and inshore waters (July 3–15).

vii. Preparation of weekly charts of (a) sea surface temperatures, (b) depth and temperature at top of thermocline, (c) depth and temperature at bottom of thermocline, and (d) magnitude of thermocline. These charts are prepared from bathythermograph observations analyzed at sea and radioed to the "Canadian Oceanographic Information Service" at Esquimalt, B. C. The data inputs have been or-

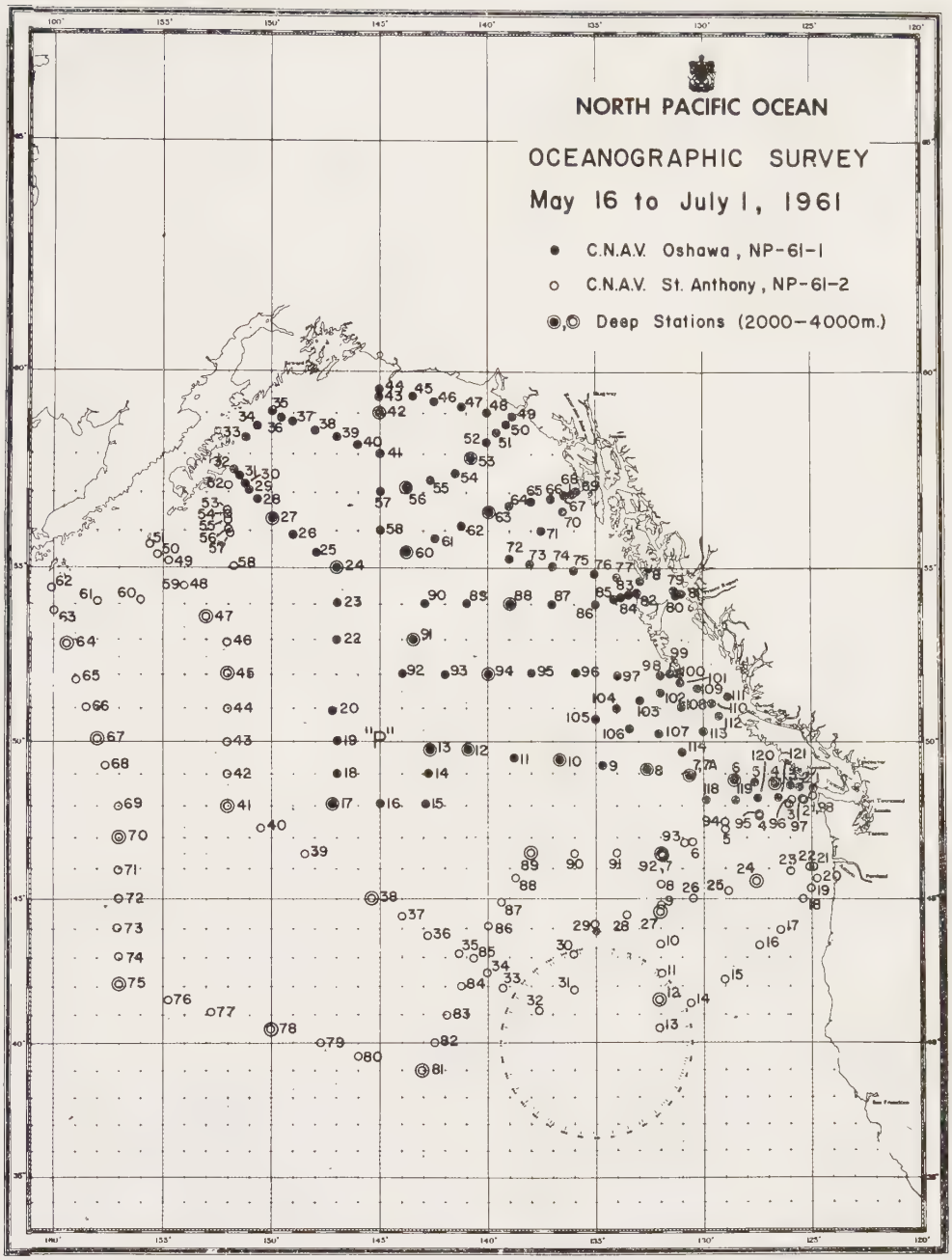


FIGURE 11. Chart showing the station positions of Surveys NP-61-1, May 16 to June 16, and NP-61-2, May 28 to July 1, 1961.

ganized from several Canadian and United States services, involving oceanographic, fisheries and naval vessels from both countries.

(b) *Oceanographic conditions in* 1961. Because of the marked seasonal heating during the 6-week period of the survey (May 16–July 1) it was impossible to draw a realistic synoptic picture of near-surface temperatures for the whole region from observed data. However, with data from Ocean Station " P ", it was possible to draw a curve, showing the temperatures at 10 metres depth throughout the period of the survey (Fig. 12). Since the water movements in the vicinity of Ocean Station " P " are slow and generally zonal, the net heat gained is considered to be primarily due to insolation. Also, this curve is considered to be fairly representative of the heating throughout the surveyed regions. On this premise the observed tem-

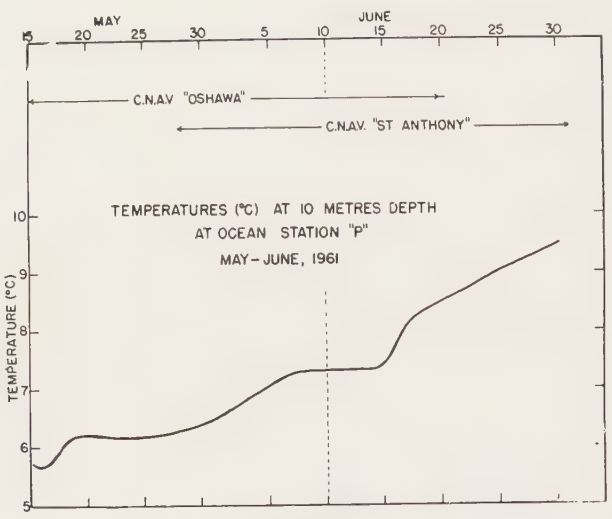


FIGURE 12.

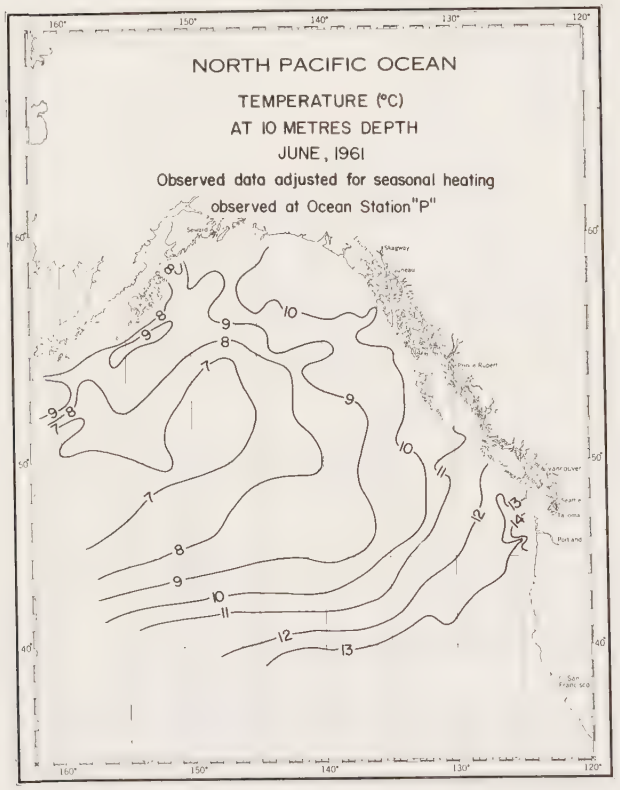


FIGURE 13.

peratures at 10 metres depth were adjusted to a common reference date, using the curve presented in Figure 12. June 10 was selected as the reference date since it was the approximate mid-point of the survey and also the rate of temperature change was least at that time. The adjusted temperatures are presented in Figure 13. These temperatures are confirmed by the weekly surface temperature charts provided by the Canadian Oceanographic Information Service. It is noteworthy that near the British Columbia coast, where advection is considered important when considering changes in heat content of the water column, the observed data, at stations only a few miles apart but observed at different times, when corrected to the reference date, June 10, agreed within 0.2°C.

The configuration of the isotherms over most of the region is similar to that observed during late summer periods of the previous years. However, in the southeastern part of the area, between Longitudes 138°W. and the coast, the trend of the isotherms was northward from as far south as Latitude 40°N., somewhat similar to that observed during 1958. If this configuration had persisted till mid-August, then by applying the change of temperature that had occurred at Ocean Station "P" from June 10 to mid-August (approximately 6°C.) waters of temperatures greater

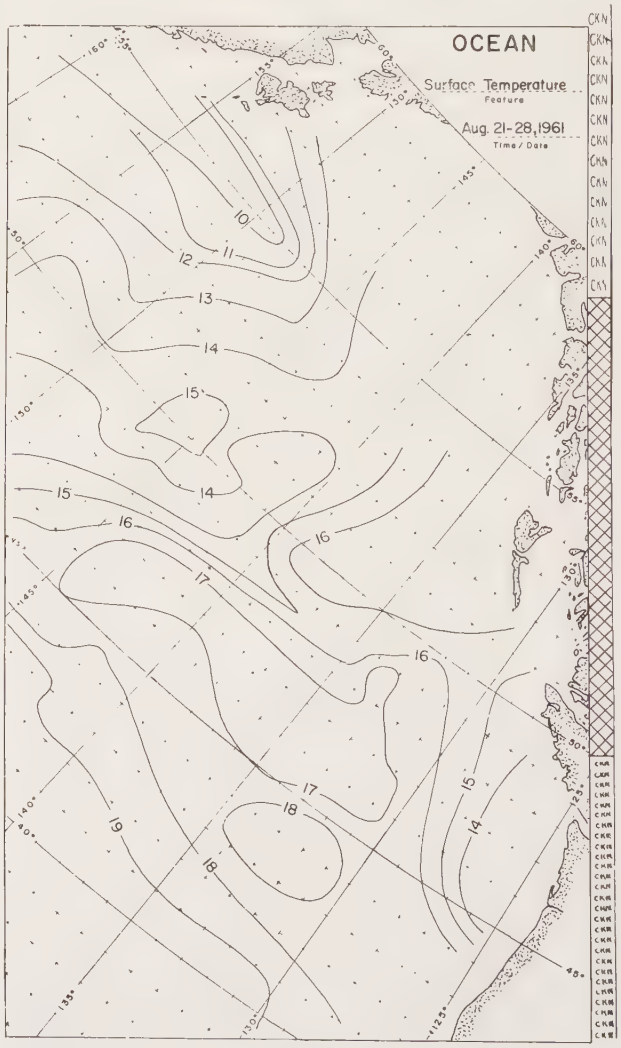


FIGURE 14.

than 16°C. would have occurred off the Canadian coast and constituted a warm water intrusion such as was observed in August, 1958. The sea surface temperature charts published by the Bureau of Commercial Fisheries, San Diego, and by the Canadian Oceanographic Information Service showed that such temperatures occurred but in isolated cells (Fig. 14). The occurrence of cells rather than a continuous area of water suggests that the intrusion was retreating or dissipating.

The occurrence of the intrusion is confirmed by the temperature distribution on the surface of salinity of 33.8‰ (Fig. 15). This figure is representative of conditions in the non-seasonal zone. The depth of this surface is shown in Figure 16 and coincides very closely with the bottom of the halocline. Warm water, of temperatures greater than 6.5°C., occurred to a slightly greater extent off the British Columbia coast than during mid-summer, 1959 and 1960, but not quite to the extent observed during 1958. Thus, there was a fairly marked intrusion of warm waters along the Canadian coast. However, the slightly irregular pattern of the isotherms suggests these waters were in the process of dissipating.

This intrusion probably reached its maximum just

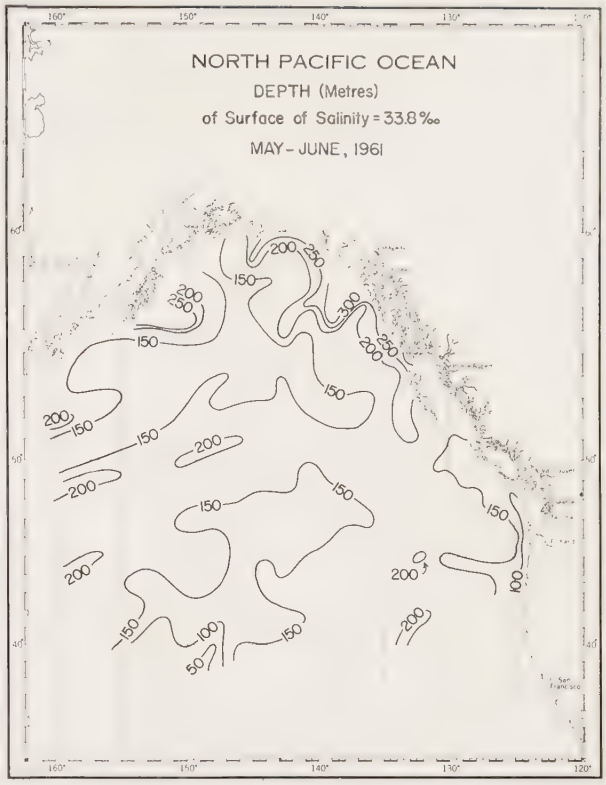


Figure 16.

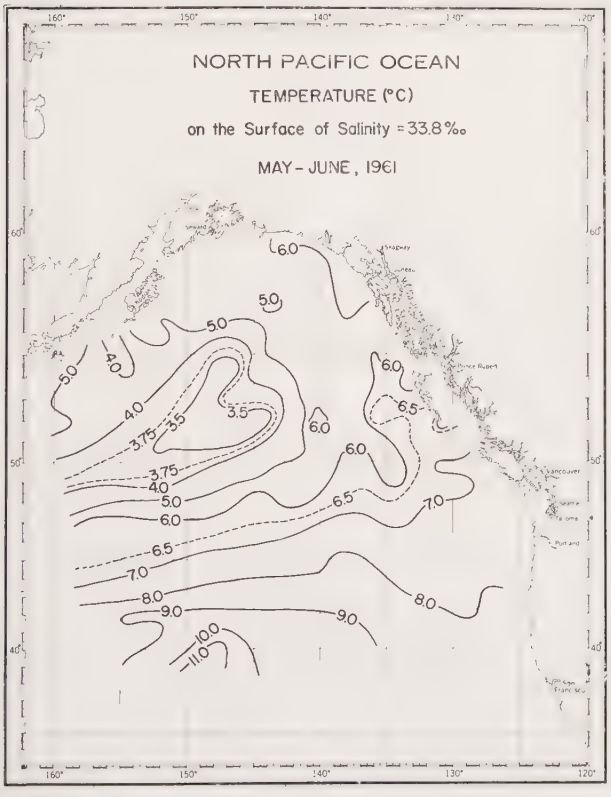


Figure 15.

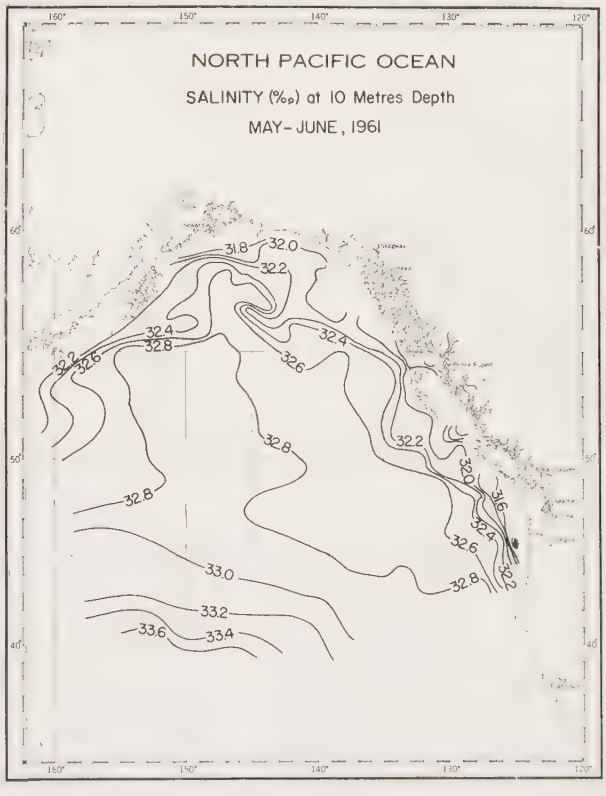


Figure 17.

before the time of the survey (May–June). Thereafter it was dissipated by intrusion of colder water from the westward. Probably in late July and certainly in August, the situation had ceased to resemble that observed in 1958, but was probably similar to that observed during the mid-summer periods of 1959 and 1960 in this region.

The salinity distribution at 10 metres depth is shown in Figure 17. This and the temperature at the western edge of the area suggests the beginning of recirculation of the surface waters in the Alaska Gyre.

The distribution of temperature and salinity at the top of the halocline are shown in Figures 18 and 19 respectively. These figures are considered to represent the conditions that occurred in the seasonal zone, from the surface to the top of the halocline, during the late winter period. The depths to which these conditions prevailed are shown in Figure 20.

In general, the temperatures of these waters were more similar to those observed during the late summer periods, 1959 and 1960, being slightly colder at the centre of the Alaska Gyre and slightly warmer off the Canadian coast during 1961. Over the whole region they were colder than observed in 1958.

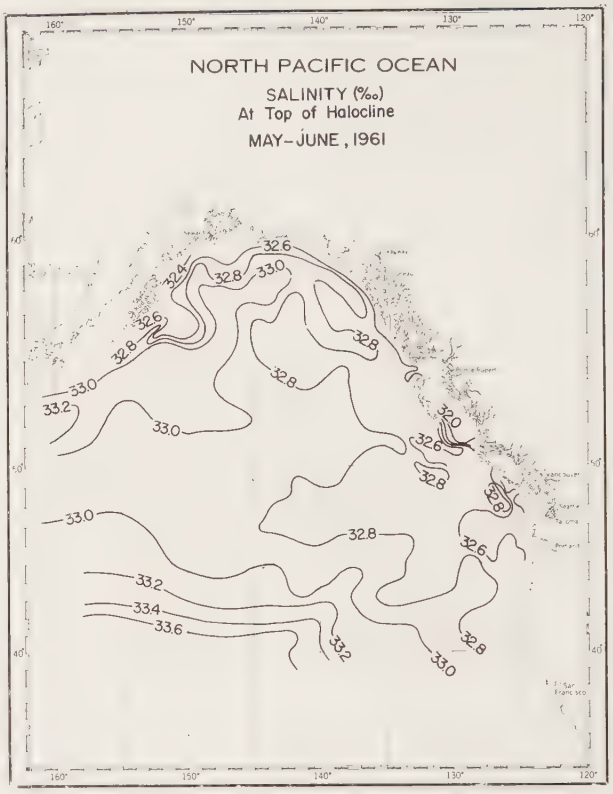


Figure 19.

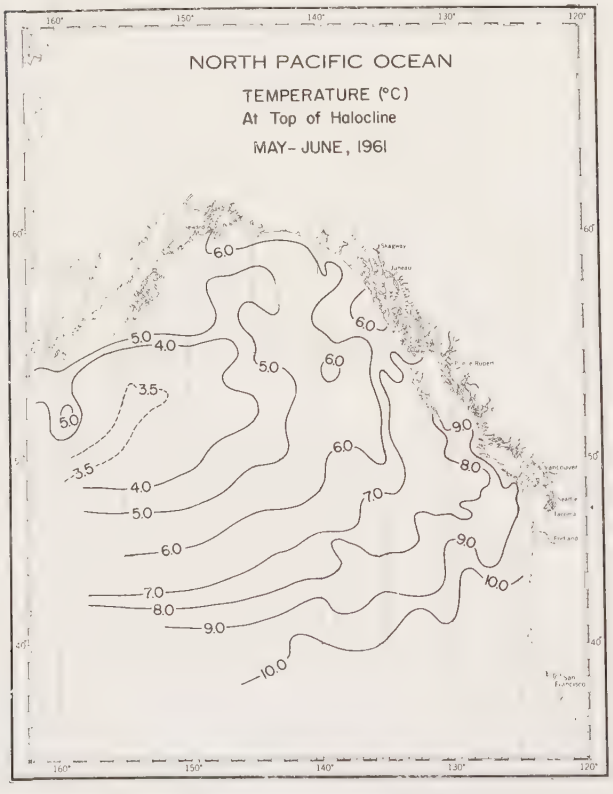


Figure 18.

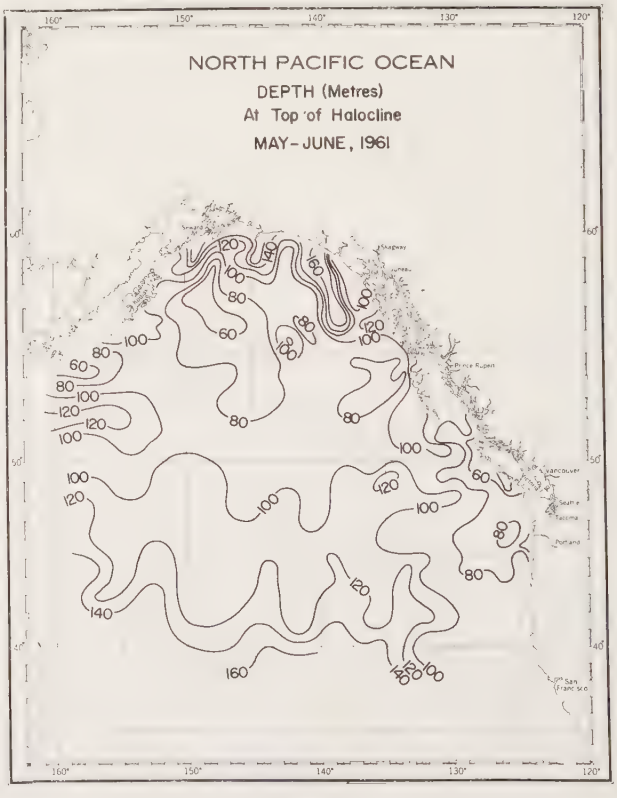


Figure 20.

Oceanographic conditions at this level off the Canadian coast and in the Alaska Gyre are summarized for the past seven years.

	Off the Canadian coast	*In the Alaska Gyre*
Mid-summer		
1955	cold	moderate
1956	cold	cold
1957	cool	moderate
1958	warm	warm
1959	moderate	moderate
1960	moderate	moderate
Early summer		
1961	moderate	cool

The salinity distribution at the top of the halocline (Fig. 19) shows the same general features and values that were observed in other years. This figure shows a tongue of relatively low salinity water (less than 32.8‰) extending westward with its axis about 48°N. Latitude. This feature, also defined by the isohaline 32.8‰, also existed at 10 metres depth (Fig. 17).

The surface circulation as deduced from the geopotential topography is presented in Figure 21. It appears that there was a strong possibility that recirculation around the Alaska Gyre was being established. None of the earlier data show the circulation so nearly closed.

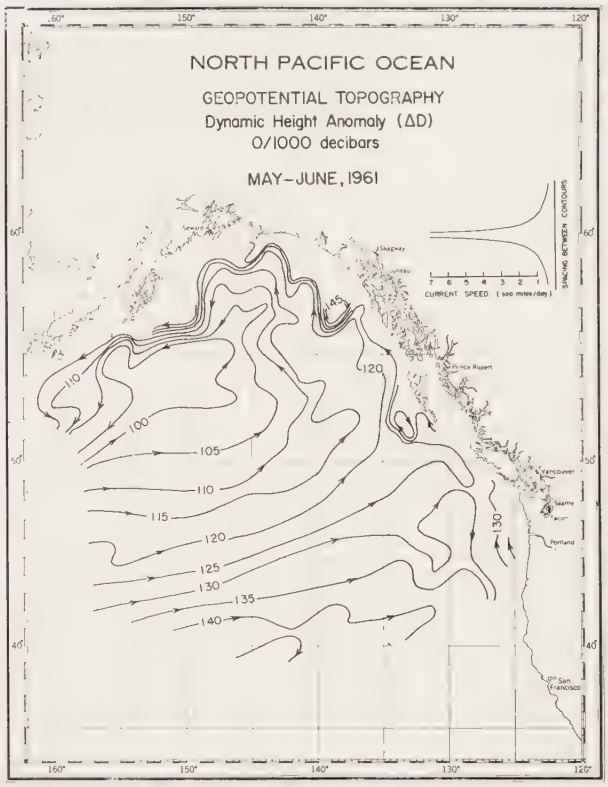


FIGURE 21.

B. REPORT ON RESEARCH BY JAPAN FOR THE INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION DURING THE YEAR 1961

Fisheries Agency of Japan, February, 1962

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INTRODUCTION

This report includes a brief summary of investigations by Japan in the North Pacific Ocean during 1961 as well as some results of analysis of past and current data. The data and samples were collected both from commercial fisheries and research vessel operations. The species studied were salmon and king crab.

Investigations in 1961 were carried out, as in previous years, on the following subjects: (1) fishing by research vessels to study the offshore distribution of salmon and to obtain salmon samples, and the collection of data and samples on salmon motherships; (2) studies of the scales of sockeye, chum and pink salmon for the purpose of identifying stocks; (3) salmon tagging experiments on the high seas, using longlines for catching fish; (4) oceanographic investigations; and (5) king crab investigations in the Bering Sea. In addition, some preliminary experiments were conducted in 1961 to study the vertical distribution of salmon in offshore waters. The main emphasis was placed on salmon tagging.

I. SALMON

A. Offshore Distribution

1. Collection of Data and Samples from the Mothership Salmon Fishery.

The salmon mothership fishery in the northwest Pacific and Bering Sea in 1961 began operating in late May and the season ended in late July. Twelve motherships operated. Table 1 gives salmon catch statistics by ten-day periods and areas of 2° latitude by 5° longitude each. These areas are shown in Figure 1. Of a total of 22.7 million salmon caught in 1961, sockeye constituted 57%; chum, 27%; pink, 14%; and coho and chinook, 1.4%. In 1957, four years before, the total catch of the mothership fishery (excluding the catch in the Okhotsk Sea) was approximately 50 million salmon, of which sockeye comprised 39%; chum, 18%; pink, 42%; and others, less than 1%. Comparing the catches of these two years, it is noted that the proportion of pink salmon was much smaller and that of sockeye salmon was much higher in 1961 than in 1957. One factor which should be taken into consideration, however, is that in 1961 more than half of the gillnets used were those of 5.2″ mesh, which were not efficient for catching pink salmon.

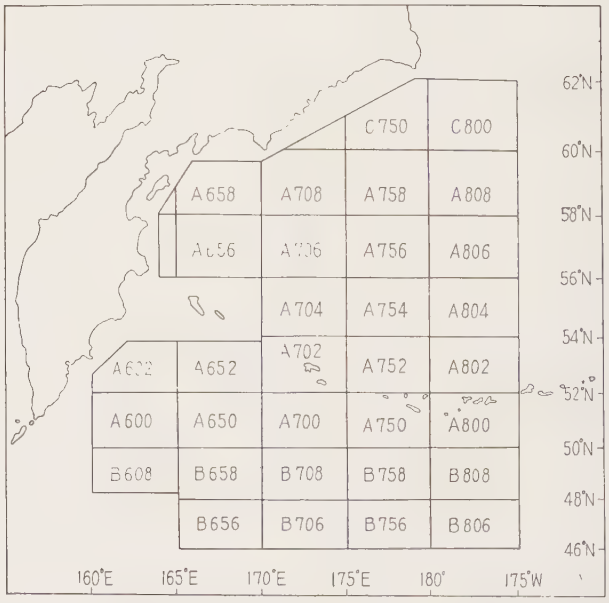

Figure 1. Statistical areas for the mothership salmon fishing, 1961.

As shown in Table 2, a total of 38,587 fish was

TABLE 1. Catch statistics of the mothership salmon fishery in Aleutian waters in 1961. (Numbers of fish caught by species, ten-day periods and areas of 2°×5° each[1])

Period	Area	Species						Cumulative quantity of gear used (in tans)
		Sockeye	Chum	Pink	Coho	Chinook	TOTAL	
May 21–31	A 650	214,669	152,336	308	—	295	367,608	78,001
	B 658	132,816	153,742	370	—	132	287,060	51,400
	B 656	206,184	136,863	28,801	3	92	371,943	98,293
	A 700	277,150	188,840	420	—	724	467,134	108,314
	B 708	237,093	285,793	4,918	—	326	528,130	97,473
	B 706	32,068	28,314	1,353	1	12	61,748	21,988
	Sub-total	1,099,980	945,888	36,170	4	1,581	2,083,623	455,469
June 1–10	A 652	12,062	1,964	—	—	2	14,028	7,210
	A 650	17,101	5,443	2	—	13	22,559	9,161
	B 656	36,590	10,168	7,724	2	35	54,519	12,426
	A 702	55,364	7,084	—	—	36	62,484	24,828
	A 700	427,600	236,421	3,989	—	482	668,492	292,503
	B 708	257,408	288,733	17,320	1	152	563,614	148,037
	B 706	35,014	27,072	5,513	1	15	67,615	21,016
	A 752	25,993	24,621	1,404	—	35	52,053	11,220
	A 750	442,509	516,344	37,855	1	726	997,435	270,552
	B 758	22,607	38,121	6,925	—	53	67,706	21,993
	A 802	168,146	32,298	3,242	—	1,440	205,126	76,284
	A 800	975,571	230,244	31,776	—	393	1,237,984	205,958
	Sub-total	2,475,965	1,418,513	115,750	5	3,382	4,013,615	1,101,188
June 11–20	A 704	12,022	7,712	5,553	—	82	25,369	11,546
	A 700	15,400	21,563	13,640	—	10	50,613	10,412
	A 752	182,671	142,295	22,435	—	1,146	348,547	87,336
	A 750	75,587	52,016	11,861	—	76	139,540	31,929
	A 806	21,440	8,165	2,877	—	396	32,878	23,748
	A 804	517,034	64,241	37,202	—	2,520	620,997	169,967
	A 802	1,833,023	251,935	83,533	—	3,855	2,172,346	381,701
	A 800	833,962	163,559	82,801	—	316	1,080,638	215,626
	Sub-total	3,491,139	711,486	259,902	—	8,401	4,470,928	932,265
June 21–30	A 602	15,357	3,171	5,389	2	14	23,933	8,347
	A 600	136,127	74,531	71,963	34	119	282,774	62,953
	B 608	157,072	157,453	75,421	468	181	390,595	52,232
	A 652	125,860	44,922	47,639	15	322	218,758	57,426
	A 650	1,045,759	435,286	369,023	136	1,314	1,851,518	323,426
	B 658	1,117,684	458,859	288,455	2,683	2,787	1,870,468	251,506
	A 702	54,438	60,341	67,331	—	265	182,375	34,230
	A 700	376,480	306,953	253,170	42	952	937,597	161,865
	B 708	160,717	74,332	83,844	82	1,128	320,103	58,408
	Sub-total	3,189,494	1,615,848	1,262,235	3,462	7,082	6,078,121	1,010,393
July 1–10	A 602	179,637	71,558	42,281	215	314	294,005	84,599
	A 600	470,323	249,344	218,193	2,457	970	941,287	246,547
	B 608	352,802	400,560	377,198	9,313	1,947	1,141,820	195,941
	A 652	216,407	90,808	72,300	455	237	380,207	102,551
	A 650	597,551	176,226	157,329	3,546	1,246	935,898	230,382
	B 658	178,541	57,780	62,178	4,885	1,370	304,754	82,391
	A 700	38,892	17,706	20,786	—	53	77,437	18,830
	Sub-total	2,034,153	1,063,982	950,265	20,871	6,137	4,075,408	961,241

Continued . . .

Table 1. (Continued.)

Period	Area	Species						Cumulative quantity of gear used (in tans)
		Sockeye	Chum	Pink	Coho	Chinook	Total	
July 11–20	A 600	46,864	9,287	9,171	378	44	65,744	26,850
	B 608	391,456	213,600	309,148	52,340	2,471	969,015	247,471
	A 658	3,079	6,677	34,188	—	5	43,949	4,485
	A 656	6,069	4,565	43,933	—	—	54,567	5,921
	A 652	58,782	15,855	25,280	264	136	100,317	35,281
	A 650	20,256	5,805	7,381	461	78	33,981	16,926
	B 658	142,615	44,776	55,393	21,588	699	265,071	91,409
	B 656	426	5,098	159	43,161	146	48,990	17,712
	A 708	11,816	29,513	87,426	6	404	129,165	16,208
	A 706	7,818	6,499	51,056	15	207	65,595	8,832
	B 706	3,171	19,958	1,614	138,978	344	164,065	53,445
	Sub-total	692,352	361,633	624,749	257,191	4,534	1,940,459	524,540
July 21–31	B 608	15,316	10,761	13,487	2,523	65	42,152	8,440
	Sub-total	15,316	10,761	13,487	2,523	65	42,152	8,440
	Grand Total	12,998,399	6,128,111	3,262,558	284,056	31,182	22,704,306	4,993,536

[1] For areas, see Figure 1.

Table 2. Number of fish sampled in mothership catches, 1961.

Species	May	June	July	Total
Sockeye	1,410	8,680	4,680	14,770
Chum	1,410	8,620	4,750	14,780
Pink	409	2,707	1,724	4,840
Coho	10	236	1,142	1,388
Chinook	277	1,512	1,020	2,809
Total	3,516	21,755	13,316	38,587

Table 3. Age composition of sockeye and chum salmon caught in the mothership fishery, 1961.

1. Sockeye

	Age							
	4_2	5_2	5_3	6_3	6_4	7_4	Others[1]	Total
Age composition (%)	4.3	35.2	25.1	31.8	0.9	1.6	1.1	100
Estimated total catch (in 1,000's of fish)	559	4,576	3,262	4,133	117	208	143	12,998

[1] Including 3_1, 4_1, 5_1, 6_2, 7_3, 7_5, 8_3, 8_4 and 8_5.

2. Chum

	Age				
	3	4	5	6	Total
Age composition (%)	2.4	41.5	53.7	2.4	100
Estimated total catch (in 1,000's of fish)	146	2,543	3,291	148	6,128

sampled from the catches of the mothership fishery for various characteristics, including (1) length (fork length), (2) weight, (3) sex, (4) gonad weight, and (5) scale samples. These data are being compiled according to the same area and time divisions as used in catch statistics.

Table 3 gives the age composition and the estimated numbers of fish by age in the total catch for sockeye and chum salmon. Table 4 gives the seasonal average numbers of fish per 1,000 tans of gillnet for the sockeye and chum salmon of various ages caught during the period 1956-1961.

Fish of ages 5_2 and 6_3 constituted the largest proportion of sockeye caught in 1961, followed by those of age 5_3. The fish of these three age categories comprised 92% of the total. Such composition corresponds to the predominance of the age groups 4_2 and 5_3 in 1960. It also corresponds to the predominance of ages 5_2 and 6_3 in 1957. Further analysis must await age composition data for coastal catches.

About 95% of the chum salmon catch in 1961 consisted of fish of ages four and five, the latter slightly outnumbering the former.

The year-to-year changes in the relative abundance of different age groups of chum salmon, as shown in Table 4, indicate a cycle of four to five years in the year-class fluctuations of this species. The predominance of five-year-old chums in 1960 and 1961, as in 1956, gives a clue to the question of the origin of chum salmon found in offshore waters in these years, because the majority of North American chum salmon become mature as four-year-olds in all years.

In 1959, as shown in Figure 2 (a), the majority of mature chum salmon taken by the Japanese mothership fishery and research vessels were four-year-olds (1955 year-class); and chum salmon runs to both Asian and North American streams in this year consisted mostly of four-year-olds. In 1960, as shown in Figure 2(b), the fish of the 1955 year-class again made up very high proportions of Asian chum salmon runs (particularly in Kamchatka and the Okhotsk districts) as five-year-olds; and chum salmon

Table 4. Seasonal average number of sockeye and chum salmon caught per 1,000 tans of gillnet in the mothership fishery, by age, 1956–1961[1][2][3].

1. Sockeye

	Age							
Year	4_2	5_2	5_3	6_3	6_4	7_4	Others	Total
1956	155	157	364	229	36	33	28	1,002
1957	89	839	488	1,252	168	138	21	2,995
1958	75	217	502	418	96	61	24	1,393
1959	129	130	390	268	136	56	33	1,142
1960	478	277	711	294	87	77	52	1,976
1961	112	923	657	833	23	41	27	2,616

2. Chum

	Age					
Year	3	4	5	6	7	Total
1956	57	520	985	25	+	1,588*
1957	76	858	259	99	+	1,292
1958	348	1,284	315	8	1	1,956
1959	74	1,659	83	1	—	1,817
1960	54	1,063	515	1	—	1,633
1961	29	509	659	30	—	1,227

* Difference between total given and actual sum of broken-down figures occurs because of rounding.

[1] Excluding Okhotsk Sea catches for 1956–1958.

[2] During 1956–59, a mesh size of 60.5 mm. (knot to knot, stretched measure) was used. In 1960, 25% or more of the nets were of 65 mm. mesh ; and in 1961, 50% or more of the nets were of 65 mm. mesh.

[3] For comparison between years, the catch per unit of effort was calculated for the period from late May to late July.

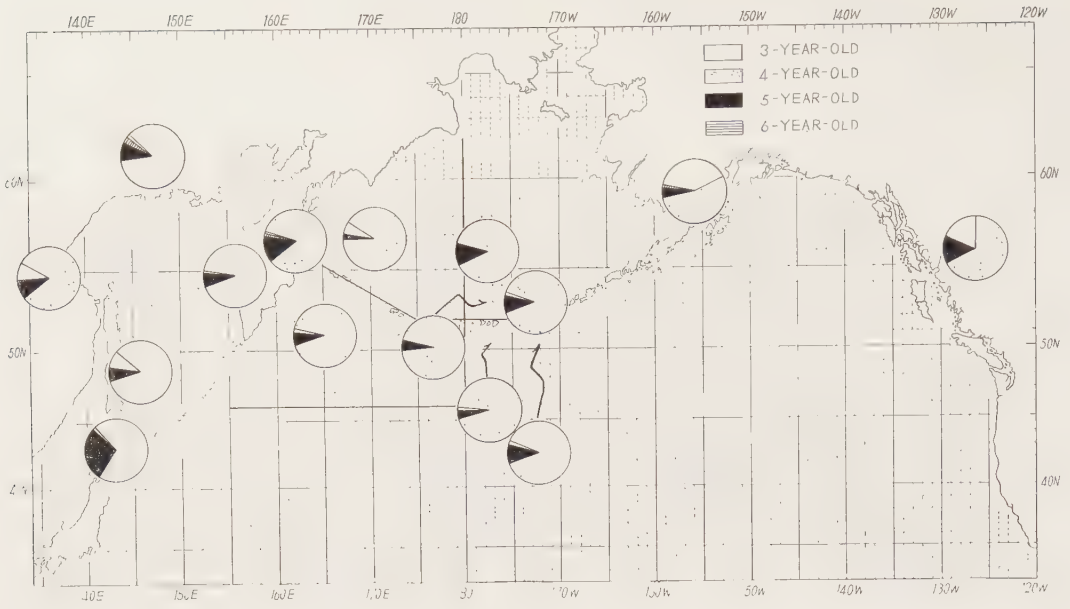

FIGURE 2 (a). Age composition of mature chum salmon in 1959.

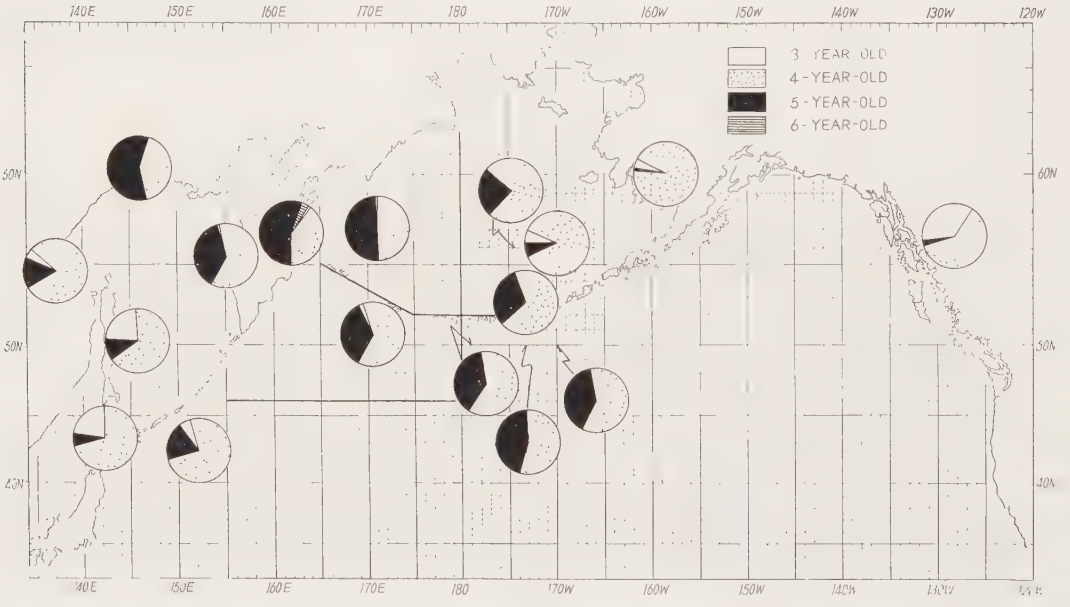

FIGURE 2 (b). Age composition of mature chum salmon in 1960.

caught in offshore waters also showed very high proportions of five-year-olds. From these findings, it can be assumed that maturing Asian chum salmon were present in very high proportions at least as far east as 170°W. in that year. In 1961 as well, five-year-old chum salmon appeared in high proportions, at least in the fishing grounds of the mothership fishery. By combining this information with analysis of research vessel data and coastal data, the distribution of Asian chum salmon in offshore waters in 1961 will be revealed to some extent.

2. Research Vessel Operations for Studying the Offshore Distribution of Salmon and Collecting Salmon Samples.

i. Vessel Operation and Gear

The *Etsuzan-maru* (150 g.t., 320 h.p.) was chartered as a government research vessel. Two cruises were

made. During the first cruise, investigations began on May 22 at 49°57′N.x165°24′W., and ended on July 3 at 45°29′N.x165°25′E. Stations in the North Pacific and the Bering Sea were occupied and emphasis was placed on the study of the distribution of maturing salmon and the vertical distribution of salmon. In the second cruise, investigations began on July 31 at 50°59′N.x166°24′E., and ended on August 20 at 50°00′N.x160°00′E. Emphasis was on the distribution of immature fish and the vertical distribution. The stations occupied during the two cruises are shown in Figure 3.

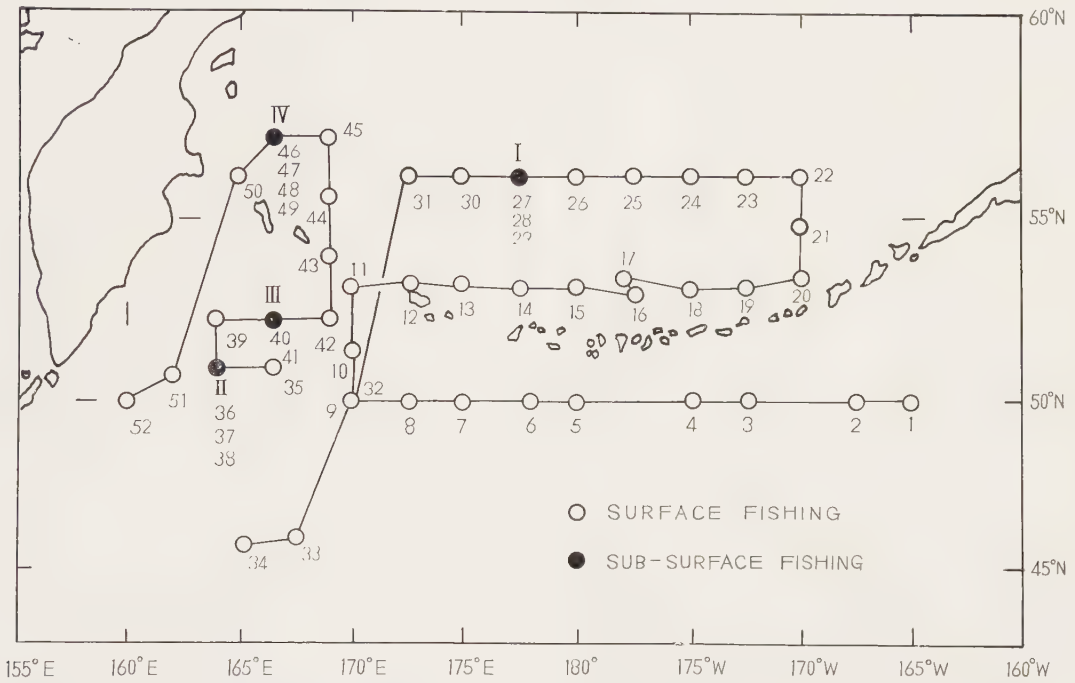

FIGURE 3. Stations occupied by the research vessel *Etsuzan-maru*. (Figures indicate operation numbers.)

The types of gear used were surface gillnets and mid-water gillnets, the latter being for the study of vertical distribution. The surface gillnets consisted of 24 shackles of the INPFC standard nets (4 shackles of $2\frac{1}{2}''$, 4 shackles of $3\frac{1}{4}''$, 12 shackles of $4\frac{1}{2}''$, and 4 shackles of $5\frac{1}{4}''$) combined with 40 shackles of 4.8″ mesh and 36-40 shackles of 5.2″ mesh (commercial mesh sizes used by the mothership fishery). The actual quantities of gillnets of the above three categories varied from operation to operation.

The mid-water gillnets used for studying the vertical distribution of salmon were made by modifying the INPFC standard gillnets so that the float line of the nets could be at any depth between the surface and a depth of 40 meters. The mesh sizes used, therefore, were $2\frac{1}{2}''$, $3\frac{1}{4}''$, $4\frac{1}{2}''$ and $5\frac{1}{4}''$, and their quantities per unit set were 1, 1, 3 and 1 shackles, respectively. Two units of these nets were used in fishing. Half of the floats used in surface netting were removed, and the total weight *in water* of one shackle of net was 2.2 kg. The nets were hung by ropes of 40 m. each, with a glass ball of about 30 cm. in diameter at the surface end of each rope. The length of rope was adjustable. In the early operations, the nets were hung at both ends of each shackle, but later another rope was attached in the middle of each shackle to reduce sagging.

ii. Offshore Distribution of Salmon

At each station, nets were cast in the evening and lifted the next morning. The location, surface temperature and direction of set was recorded and fish from nets of each mesh size were measured and scale-sampled. As a principle, measurements and scale sampling were done aboard the vessel, but part of the catch, particularly fish caught by nets of commercial mesh sizes, were brought back frozen to be measured and scale-sampled on land. A considerable number of frozen samples became useless because of losses of identification tags. Fish were measured and examined for fork length, weight, sex and gonad weight.

The catch and associated data are shown in Table 5 for each station. Table 6 gives the numbers of sockeye and chum salmon by age and maturity for each station.

Distribution of maturing sockeye salmon. In waters of the North Pacific approximately along the 50°N. line occupied during late May and early June, fairly high concentrations of sockeye were found both in the area around 165°W. and in the vicinity of 175°E. Fish were less abundant between these two areas. In Bering Sea waters close to the Aleutian Chain, fish were scarce at stations of east longitude in early June, but the catch per tan increased sharply when the vessel entered waters of west longitude in mid-June. Such high abundance was continuous eastward to the eastern end of the waters occupied (170°W.) and northward to the vicinity of 56°N.x170°W. The highest catch per tan of 12 fish was recorded at 55°N.x-170°W.

In central Bering Sea waters occupied in mid-June and late June, abundance was not very high, the the catch per tan mostly being around 0.7 fish. The same station (50°N.x170°E.) was occupied both in the first and second cruises with an interval of about one month. The catch per tan on June 3 was 1.1 and that on June 29 was 1.5. However, about two-

Table 5. Catch records of the research vessel *Etsuzan-maru*, 1961.

1st cruise

Oper. no.	Date of haul	Location		Dir. of set	Surf. temp.	No. of tans	Catch (in numbers of fish)					
							Sock-eye	Chum	Pink	Coho	Chi-nook	Total
1	5/23	49–57N.	105–24W.	N.68W.	5.0	104	225	54	6	—	—	285
2	5/24	49–57N.	167 27W.	N.58W.	4.9	40	28	10	—	—	1	39
3	5/27	50–00N.	172–30W.	S.42W.	—	40	5	13	2	—	—	20
4	5/28	50–00N.	175–06W.	S.76W.	4.9	40	12	4	—	—	—	16
5	5/30	50–00N.	180–00	N.46W.	4.2	104	39	41	—	—	1	81
6	5/31	50–01N.	178–05E.	N.74W.	4.5	24	54	66	—	—	—	120
7	6/1	50–02N.	175 05E.	S.25W.	4.2	24	68	35	1	—	—	104
8	6/2	50–00N.	172 30E.	S.79W.	4.0	12	12	4	1	—	—	17
9	6/3	50–00N.	170–00E.	N.50W.	4.1	104	120	37	1	—	—	158
10	6/4	51–42N.	170–00E.	N.38W.	4.1	80	130	15	—	—	—	145
11	6/5	53–20N.	170 00E.	N.25W.	4.7	104	50	20	—	—	1	71
12	6/6	53–30N.	172–30E.	N.61E.	5.0	104	38	28	1	—	5	72
13	6/7	53–20N.	175–00E.	S.28W.	4.2	104	30	40	3	—	—	73
14	6/8	53–20N.	177–30E.	S.38E.	4.8	94	13	13	3	—	9	38
15	6/9	53–20N.	180–00	S.80E.	4.8	102	13	8	1	—	—	22
16	6/10	53–30N.	177–30W.	S.67E.	4.8	101	232	14	3	—	18	267
17	6/11	53–27N.	178 10W.	S.58E.	5.4	24	67	9	1	—	—	77
18	6/13	53–20N.	175–00W.	N.52E.	5.8	101	88	23	9	—	4	124
19	6/14	53–20N.	172–37W.	S.65E.	5.8	101	339	58	54	—	1	452
20	6/15	53–30N.	170–00W.	N.82W.	6.7	101	96	37	3	—	—	136
21	6/16	54–40N.	170 00W.	S.60W.	7.2	101	1338	300	33	—	10	1681
22	6/17	56–00N.	170 00W.	S.77W.	7.0	101	508	82	7	—	1	598
23[1]	6/18	56–00N.	172–36W.	S.45W.	6.9	24	20	5	9	—	—	34
24[1]	6/19	56–00N.	175–30W.	N.64W.	5.9	101	85	39	30	—	2	156
25	6/20	56–00N.	177–30W.	S.73W.	5.3	77	54	16	52	—	—	122
26	6/21	56–00N.	180 00	S.69E.	5.0	40	69	8	9	—	—	86
27	6/22	56–00N.	177–30E.	N.33E.	4.6	101	64	67	88	—	—	219
28	6/23	56–00N.	177–30E.	N.83E.	5.3	12	1	3	3	—	2	9
29	6/24	56–00N.	177–30E.	S.60E.	5.1	12	2	—	1	—	—	3
30	6/25	56–00N.	175–00E.	S.81E.	5.1	61	44	56	140	—	1	241
31	6/26	56–00N.	172–30E.	N.88W.	5.4	101	34	28	208	—	1	271
32	6/29	50–00N.	170 00E.	S.15W.	6.0	100	220	56	162	—	2	440
33	7/2	45–30N.	167 30E.	N.59E.	6.8	100	2	39	161	88	—	290
34	7/3	45–29N.	165–25E.	S.24W.	7.3	100	1	9	395	138	4	547
Total							4101	1237	1387	226	63	7014

Continued . . .

TABLE 5. (Continued.)

2ND CRUISE

Oper. no.	Date of haul	Location		Dir. of set	Surf. temp.	No. of tans	Catch (in numbers of fish) Sock-eye	Chum	Pink	Coho	Chi-nook	TOTAL
35	8/1	50 59N.	166–24E.	N.47E.	8.5	89	46	32	2	70	—	150
36[1]	8/2	50–56N.	164–12E.	N.45E.	10.4	12	—	3	—	—	—	3
37[1]	8/3	51–00N.	164–00E.	N.67W.	10.2	12	—	—	—	—	—	—
38	8/4	51–00N.	164–00E.	N.21E.	10.6	89	65	100	3	49	1	218
39	8/5	52–30N.	164–00E.	S.68W.	9.7	89	116	40	3	54	1	214
40	8/6	52–30N.	166–33E.	N. 3W.	10.3	89	142	36	1	28	2	209
41[1]	8/6	52–30N.	166–33E.	N. 3W.	10.3	12	1	1	—	—	—	2
42	8/7	52–30N.	169–00E.	S.71W.	9.7	89	52	13	1	87	3	156
43	8/8	54–00N.	169–00E.	N. 2W.	9.7	89	52	44	1	19	1	117
44	8/9	55–30N.	169–00E.	S.60W.	9.8	89	22	33	1	21	—	77
45	8/10	57–00N.	169–00E.	S.30E.	10.5	29	29	16	—	2	—	47
46	8/11	56–00N.	169–04E.	S.89E.	10.6	29	29	24	—	5	—	58
47[1]	8/12	57–00N.	166–30E.	N.48E.	11.0	89	91	15	2	7	—	115
48[1]	8/13	57–00N.	166–30E.	S.33W.	11.3	12	1	10	—	—	—	11
49	8/14	57–00N.	166–30E.	N.50W.	11.1	12	—	—	—	—	—	—
50	8/15	56–00N.	165–00E.	N.96E.	13.7	89	49	38	—	9	—	96
51	8/19	50–51N.	161–45E.	N. 1E.	13.0	60	1	109	—	119	4	233
52	8/20	50–00N.	160–00E.	N.14W.	13.2	89	5	186	4	139	5	339
TOTAL							701	700	18	609	17	2045

[1] Catch by mid-water gillnets.

thirds of the fish taken on June 29 were immature. In August, sockeye salmon were found in waters around the Kommandorski Islands and off the east coast of Kamchatka, the catch per tan ranging from 0 to 1.5. These fish were a mixture of maturing and immature sockeye.

Distribution of maturing chum salmon. Abundance was generally low in waters south of the Aleutian Chain occupied during late May and early June, except for catches per tan of 1.1 to 2.0 recorded between 175°E. and 177°E. along 50°N. Also, in waters north of the Chain, along 53°N., investigated in early and mid-June, the abundance of chum salmon was generally low, the catch per tan being 0.1 to 0.6. A catch of 2.7 fish per tan was obtained at 55°N.x-170°W. When waters along 56°N. were occupied in mid and late June, chum salmon were slightly more abundant. The catch per tan ranged from 0 to 0.8. In waters around the Kommandorski Islands and off the east coast of Kamchatka occupied in August, the catch per tan ranged from 0.1 to 1.7, but more than half of the fish caught at any station were immature.

Distribution of pink salmon. The abundance of pink salmon was very low when waters south of the Aleutians were investigated in late May and early June, the catch per tan being less than 0.2. When waters north of the Aleutians were investigated along 53°N. in early and mid-June, pink salmon were very scarce at western stations, but their numbers increased slightly toward the east. A catch per tan of 1.3 fish was obtained at around 53°N.x172°30′W. The catches made along the 56°N. line were lower toward the east and higher toward the west. At the easternmost station (170°W.) the catch per tan was only 0.3, but it was 1.9 at 177°30′E., 5.6 at 175°E., and 6.3 at 172°30′E. Also, a high catch per tan of 4.0 was obtained at 50°N.x170°E. on June 29. When waters around the Kommandorski Islands and off the east coast of Kamchatka were investigated in August, the catch per tan of pink salmon was either less than 0.2 or 0.

Distribution of immature sockeye salmon. In waters south of the Aleutian Islands occupied in late May and early June, practically no immature sockeye were caught. Also, at stations along 53°N. (north of the Chain) occupied in early and mid-June, the catch of immature sockeye was only 1–2 fish per set or none. When stations along 56°N. were fished in mid and late June, the catch of immature sockeye was usually several fish per set. They comprised only about 10% of the total number caught at each station. The catch made at 50°N.x170°E. on June 29 included 106 immatures out of 143 sockeye salmon

TABLE 6. Catch by the *Etsuzan-maru* of sockeye and chum salmon, by age and by maturity, 1961.

Oper. no.	Date of collection	Sockeye (ocean age)			Sockeye		Chum (age)					Chum	
		1	2	3	Mature	Immature	2	3	4	5	6	Mature	Immature
1	5/23	1	42	21	104	2	—	—	8	9	1	30	1
2	5/24	—	14	10	27	1	—	—	2	6	—	10	—
3	5/27	—	2	3	5	—	—	—	5	8	—	13	—
4	5/28	—	1	8	12	—	—	—	—	2	—	4	—
5	5/30	—	4	13	18	—	—	—	2	11	—	13	—
6	5/31	—	3	34	54	—	—	—	12	46	—	59	7
7	6/1	—	9	51	68	—	—	—	6	24	1	35	—
8	6/2	—	—	3	12	—	—	—	1	3	—	4	—
9	6/3	—	3	36	47	1	—	—	1	19	—	22	—
10	6/4	—	5	52	59	—	—	—	—	—	—	15	—
11	6/5	—	3	14	19	—	—	—	2	9	2	18	—
12	6/6	—	4	30	38	—	—	—	1	27	—	28	—
13	6/7	—	8	17	28	2	—	—	6	30	3	40	—
14	6/8	—	2	8	13	—	—	—	2	11	—	12	—
15	6/9	—	5	7	12	1	—	—	—	7	1	8	—
16	6/10	1	35	61	105	2	—	—	4	—	—	6	—
17	6/11	1	14	29	66	1	—	—	2	5	—	8	1
18	6/13	—	17	21	41	1	—	1	13	5	—	19	3
19	6/14	—	85	63	176	1	—	3	30	4	—	34	2
20	6/15	—	32	51	96	—	—	2	21	11	—	37	—
21	6/16	1	118	211	352	2	—	2	67	9	—	77	—
22	6/17	—	48	53	126	—	—	—	18	8	2	30	—
23	6/18	—	7	9	19	1	—	—	4	1	—	4	1
24	6/19	1	5	33	43	1	—	1	6	2	—	9	—
25	6/20	—	3	41	49	5	—	—	7	8	—	16	—
26	6/21	—	7	52	69	—	—	—	3	5	—	8	—
27–29	6/22 24	1	7	23	30	3	—	—	3	12	—	17	—
30	6/25	—	8	23	29	6	—	1	11	18	1	33	—
31	6/26	—	2	14	14	2	—	—	5	2	—	7	—
35	8/1	1	12	7	11	9	—	3	4	—	—	7	1
36–38	8/2–4	1	24	7	30	18	—	6	19	6	2	1	1
39	8/5	2	61	17	53	36	2	3	15	1	—	41	19
40–41	8/6	4	90	7	8	104	—	5	16	1	—	11	15
42	8/7	—	33	—	3	48	—	3	4	1	—	16	10
43	8/8	3	40	4	3	37	3	14	24	3	—	2	6
44	8/9	2	18	—	2	19	1	2	18	4	1	8	35
45	8/10	—	16	10	5	24	1	4	14	4	—	10	23
46–49	8/11–14	—	44	8	32	32	—	2	7	1	—	2	21
50	8/15	14	26	3	22	27	20	7	8	2	—	2	36
51	8/19	—	—	1	—	1	—	10	23	4	1	15	24
52	8/20	—	—	1	2	3	—	43	89	5	2	55	131

measured. The proportion of immatures reached 50-95% in the sockeye catches made around the Kommandorski Islands and off East Kamchatka in August.

Distribution of immature chum salmon. At stations occupied during the first cruise, no, or very few, immature chums were found in the catch. In contrast, 50-95% of the chum salmon caught around the Kommandorski Islands and off East Kamchatka during August were immature, including considerable numbers of fish of age two.

iii. Study of Vertical Distribution

Experimental fishing for studying the vertical distribution of salmon was carried out at Stations I, II, III and IV, as shown in Figure 3, nets being suspended at depths of 10, 20, 30 and 40 m. (in terms of the distance between sea surface and float line). The results are shown in Table 7.

TABLE 7. Results of vertical distribution research conducted by the *Etsuzan-maru* in 1961.

Oper. no.	Date of haul	Location	Depth fished	Hours fished	No. of tans	Catch (in numbers of fish) Sock-eye	Chum	Pink	Coho	Chi-nook	TOTAL
I–0[1]	6/22	56–00N. 177–30E.	0–6 m.	11	24	33	19	26	—	—	78
I–1	6/23	56–00N. 177–30E.	10–16 m.	11	6	1	2	3	—	—	6
I–2	6/23	56–00N. 177–30E.	20–26 m.	11	6	—	1	—	—	2	3
I–3	6/24	56–00N. 177–30E.	30–36 m.	11	6	2	—	1	—	—	3
I–4	6/24	56–00N. 177–30E.	40–46 m.	11	6	—	—	—	—	—	—
II–0[1]	8/4	51–00N. 164–00E.	0–6 m.	11	24	26	30	—	17	1	74
II–1	8/2	51–00N. 164–00E.	10–16 m.	11	6	—	3	—	—	—	3
II–2	8/2	51–00N. 164–00E.	20–26 m.	11	6	—	—	—	—	—	—
II–3	8/3	51–00N. 164–00E.	30–36 m.	11	6	—	—	—	—	—	—
II–4	8/3	51–00N. 164–00E.	40–46 m.	11	6	—	—	—	—	—	—
III–0[1]	8/6	52–30N. 166–32E.	0–6 m.	11	24	58	14	—	13	1	86
III–1	8/6	52–30N. 166–32E.	10–16 m.	11	6	1	1	—	—	—	2
III–2	8/6	52–30N. 166–32E.	20–26 m.	11	6	—	—	—	—	—	—
IV–0[1]	8/12	57–00N. 166–30E.	0–6 m.	11	24	55	8	—	3	—	66
IV–1	8/13	57–00N. 166–30E.	10–16 m.	11	6	1	9	—	—	—	10
IV–2	8/13	57–00N. 166–30E.	20–26 m.	11	6	—	1	—	—	—	1
IV–3	8/14	57–00N. 166–30E.	30–36 m.	11	6	—	—	—	—	—	—
IV–4	8/14	57–00N. 166–30E.	40–46 m.	11	6	—	—	—	—	—	—
TOTAL						177	88	30	33	4	332

[1] Catch by surface gillnets.

The following procedure was followed: the surface layer was fished on the first day; layers of 10 and 20 meters were fished by one unit of mid-water gillnets each on the second day; and layers of 30 and 40 meters were fished by one unit of mid-water gillnets each on the third day. Changes were made, however, depending on the circumstances. Fishing was carried out only during the night. The depth of the gillnets was about 6 m. (finished depth), which means a water layer between 10 and 16 m. from the surface was fished with a rope length of 10 meters, etc.

Figure 4 shows the catch per unit of mid-water gillnet (6 shackles each) for each layer fished at each station, with the vertical temperature distribution at the station.

Because of the preliminary nature of the study of vertical distribution in 1961, few results were obtained. However, it was shown that, in waters west of 180°, too, salmon were found at considerably greater depths than the depths fished by night surface gillnetting (0–6 m.). This tendency was more obvious for chum salmon than for the other species. Also, the vertical distribution of salmon appeared to be somewhat related to the vertical distribution of water temperature. In the early part of the season, when a thermocline had not developed, salmon were scattered vertically, while after the establishment of a thermocline, salmon tended to be concentrated in the surface layer.

Age and maturity were examined for salmon caught by mid-water gillnets, and it was indicated that there might be some relationship between maturity and vertical distribution; the proof of this hypothesis, however, must await future studies.

3. Gillnet Selectivity Curve.

Since biological investigations by the INPFC for the purpose of learning the offshore distribution of salmon have been carried out by using gillnets, it is important to know the nature of the selectivity inherent in this type of gear. Hence, an attempt was made to determine the selectivity curve for salmon gillnets. The result is only approximate, because analysis was based on data currently available and no special experiments were conducted for this purpose. The study was made by the joint reporting group on the offshore distribution of salmon.

Let l equal the length of fish and d the size of mesh, and express the relative efficiency of nets of mesh d for catching fish of length l as $E(l, d)$. If we assume that, for any given values of l and d, the relation $E(l, d) = E(kl, kd)$ holds, where k is any constant, it is possible to determine the relative efficiency of a

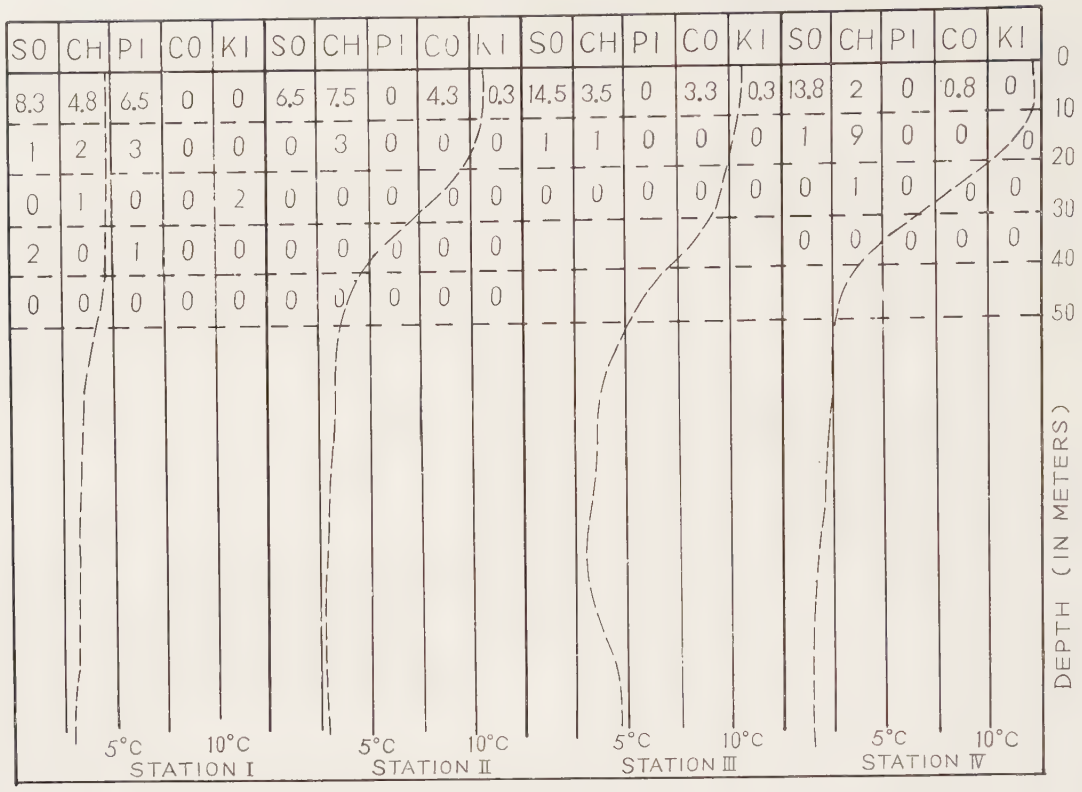

FIGURE 4. Vertical distribution of salmon catches by gillnets and of water temperature (°C) from the surface to 50 m. depth (catch shown in number of salmon per six shackles of INPFC standard gillnets).

mesh size for catching fish of various lengths (namely, the mesh selectivity curve) from catch data obtained for fish of a length class by using nets of various mesh sizes. The method is described below.

Let us assume that, for length class i, $C_{ij}(j=1,2,\ldots\ldots n)$ fish were caught by using mesh sizes $d_1, d_2,\ldots\ldots d_j,\ldots\ldots d_n$, respectively. Assuming that C_{ij} is proportional to $E(l_i, d_j)\times N_i$ (N_i equals the number of fish of length l_i in the population) and taking, for example, d_1 as the mesh size against which the relative efficiency of other mesh sizes is to be measured, we obtain,

$$\frac{C_{ij}}{C_{i1}} = \frac{E(l_i, d_j)\times N_i}{E(l_i, d_1)\times N_i} = \frac{E(l_i, d_j)}{E(l_i, d_1)}.$$

Letting

$$\frac{E(l_i, d_j)}{E(l_i, d_1)} = E'(l_i, d_j) = a_i E(l_i, d_j),$$

we obtain the following series for the efficiency of various mesh sizes relative to that of mesh size d_1:

$$E'(l_i, d_1), E'(l_i, d_2),\ldots E'(l_i, d_j),\ldots E'(l_i, d_n).$$

By definition $E'(l_i, d_1) = 1$. Using the original assumption, the above series can be transformed to the following series:

$$E'(l_i, d_1), E'(l_i d_1/d_2, d_1),\ldots E'(l_i d_1/d_j, d_1),\ldots E'(l_i d_1/d_n, d_1).$$

This series is an expression of the relative efficiencies of mesh size d_1 for catching fish of lengths l_i, $l_i d_1/d_2,\ldots l_i d_1/d_j,\ldots l_i d_1/d_n$. In other words, it is an expression of gillnet selectivity for mesh size d_1.

The data used for calculation are those obtained by the United States research vessels *Paragon* and *Pioneer* in 1957, by the *Attu* and *Pioneer* in 1958, and by the Japanese research vessel *Kano-maru* in 1959. Using the length frequency distributions of the catches of sockeye, chum and pink salmon made by gillnets of $2\frac{1}{2}''$, $3\frac{1}{4}''$, $4\frac{1}{2}''$ and $5\frac{1}{2}''$ meshes, the length frequencies of fish of each species which would have been obtained if the same quantities of nets of the four different mesh sizes had been used were calculated. The above theory was applied to these calculated values.

If the number of different mesh sizes (n) is sufficiently large, it will be possible to estimate a selectivity curve even from catch data for one length class. In

this case, however, since catch data were available only for a limited number of different mesh sizes, only two or three points could be plotted from data for any one length class, resulting in a very incomplete curve. Accordingly, it was necessary to combine different series of $E'(l_i, d_j)$ obtained from data for different length classes to give one selectivity curve $E(l_i, d_j)$. The following procedure was used. Two sets of data for two different length classes, i and r, which satisfy the relation $l_i d_1/d_j \fallingdotseq l_r d_1/d_s$, where d_j and d_s are two different mesh sizes, were compared; and a correction factor a_i or a_r was determined to make the two sets of data give the same values of relative efficiency $E(l_i, d_j)$. Thus, two series of relative efficiency values obtained separately from data for two length classes, i and r, were combined to give one curve. This procedure was repeated using different sets of data until the final selectivity curve was obtained.

In the course of the above procedure, there were a few cases in which the basic assumption did not seem to be met. A certain bias was recognizable due to the differences in body shape or fatness between young immature fish and maturing fish. Also, in some cases, the shape of a certain portion of the selectivity curve was assumed *a priori*, and values for other portions were calculated in relation to the assumed portion. This was necessary because the points representing the selectivity curve were very scarce for certain length classes as a result of too great intervals between some mesh sizes.

Because of the various limitations in the basic data used, the curve obtained was only a very rough approximation but it is still useful for learning the features of gillnet selectivity. Figure 5 shows the estimated selectivity curves for sockeye salmon for the four mesh sizes used by the INPFC research vessels and a composite selectivity curve therefrom. Figure 6 gives an incomplete selectivity curve, which indicates at what length of fish the efficiency of $4\frac{1}{2}''$ mesh for catching pink salmon begins to increase.

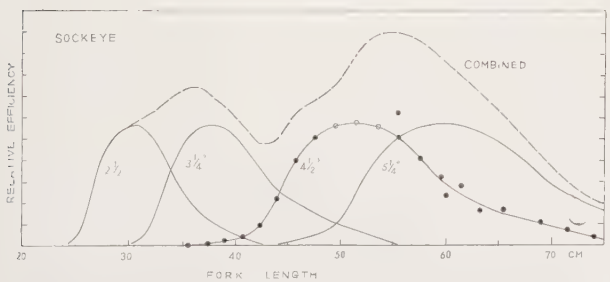

FIGURE 5. Individual selectivity curve on sockeye salmon of the INPFC standard gillnets of four different mesh sizes and the combined curve assuming the four kinds of nets are used in equal number. ●-points gained by the calculation of the actual data. ○-points placed empirically.

These selectivity curves are asymmetrical, being flatter toward the right. This is a fairly well known fact and is reasonable from a theoretical viewpoint.

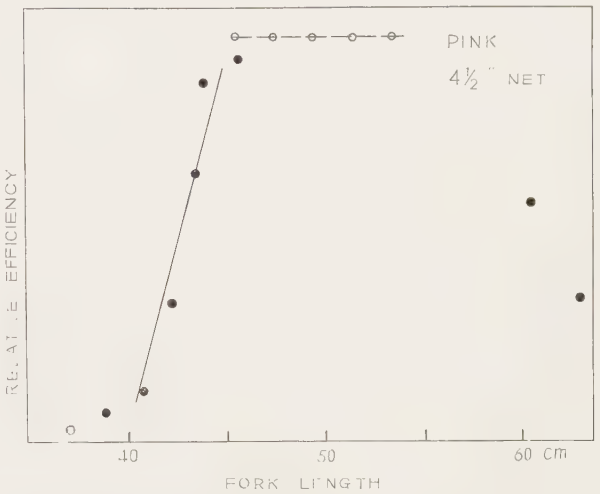

FIGURE 6. Approximate selectivity curve on pink salmon of $4\frac{1}{2}''$-mesh gillnets. Open circles were given *a priori* and closed circles determined in relation to the open circles.

The composite selectivity curve obtained by combining the curves for the four mesh sizes is fairly irregular. If it is desirable to have a smooth composite selectivity curve, when equal quantities of nets of different mesh sizes are used, the mesh sizes should be in a geometric series.

B. Studies to Distinguish Stocks

1. Sockeye Scale Studies.

Kubo (1958) and Kubo and Kosaka (1959) attempted to distinguish stocks of sockeye found in offshore waters by using scale characteristics. In his study, the sample sizes and areas of sampling were inadequate for the coastal samples from Asia and North America that were used as standards for comparison; also, his study was limited to age groups 6_3 and 5_2. Using criteria similar to those studied by Kubo, sockeye salmon of age groups 4_2, 5_2, 5_3, 6_3 and 6_4 from such North American streams as the Ugashik, Egegik, Naknek, Kvichak, Wood and Chignik Rivers and such Asian streams and lakes as the Kamchatka, Ozernaia, Bolshaia and Icha Rivers, and Blizhniaia

and Dalniaia Lakes, were examined for the usefulness of scale characters. All samples used were from maturing fish.

Alaskan samples were obtained under an established program of exchange of scale impressions between the United States, Canada and Japan and Asian samples were given by the U.S.S.R. through the Japan-Soviet Fisheries Commission (actual scales). The period of sampling varied from 1956 to 1960, depending on particular streams. Measurements used were as follows: scale radius corresponding to the fresh-water period of life (this was considered useful by Kubo); ratio of the first ocean growth zone to the distance between the nucleus and the second ocean annulus (winter ring); the number of circuli formed during the first year in the ocean; and the ratio of the first ocean growth zone to the second ocean growth zone. The frequency distribution and mean value were calculated from the measurements for each sample, and comparison was made between samples. (Only mean values are shown in Table 8.)

All characters other than the radius for the fresh-water period failed to show significant differences

Table 8. Average distance between the nucleus and the outer edge of the fresh-water zone of scales for sockeye salmon sampled from various spawning rivers of Asia and North America. (Unit: 0.02 mm., figures in brackets are numbers of specimens in samples.)

		4_2				5_2				5_3				6_3					6_4	
	River	1956	1957	1958	1959	1957	1958	1959	1960	1956	1957	1958	1959	1960	1957	1958	1959	1960	1959	1960
1	Chignik River					(39)	(36)	(29)					(24)		(70)	(54)	(104)			
						14.6	15.1	16.0					20.8		17.8	20.1	21.1			
2	Ugashik River	(41)	(35)			(55)	(28)				(30)	(52)	(67)				(53)			
		22.8	21.4			22.8	21.5				28.0	28.9	33.1				29.1			
3	Egegik River									(63)		(55)	(62)		(76)	(28)	(26)			
										34.6		32.5	34.5		32.3	33.1	33.6			
4	Naknek River						(19)					(64)	(68)			(27)				
							21.9					29.0	28.8			30.1				
5	Kvichak River	(54)			(30)	(51)	(22)			(33)	(33)	(59)	(205)			(51)				
		22.0			23.6	24.4	21.7			30.2	28.4	30.9	32.9			28.9				
6	Wood River	(46)		(105)	(81)	(28)							(23)							
		23.9		20.8	20.5	19.0							26.2							
7	Kamchatka River								(66)				(34)					(23)		
									15.2				25.8					20.7		
8	Blizhniaia Lake											(42)								
												18.0								
9	Dalniaia Lake											(57)								
												31.7								
10	Ozernaia River													(129)			(102)	(29)	(21)	(22)
														24.7			25.7	22.4	29.1	28.1
11	Bolshaia River							(45)	(31)								(34)			
								14.5	14.8								228			
12	Icha River								(42)											
									15.1											

between samples. The radius for the fresh-water period varied from stream to stream; but, in general, it was greater for Alaskan streams (except the Chignik River) than for the streams of the Kamchatka Peninsula (except Dalniaia). Comparison between streams for each age group throughout the period of sampling indicated the following:

Fish of age 4_2. There are no data available for Asian areas, and mean sample values of 20.5 to 23.9 (unit: 0.02 mm.) were observed for Bristol Bay sockeye.

Fish of age 5_3. Chignik sockeye showed a mean value of 20.8, which is fairly close to the value of 18.0 obtained for Blizhniaia sockeye. Dalniaia sockeye showed a mean value of 31.7 with a large variance, their values overlapping those of Bristol Bay sockeye. The sample means for Bristol Bay sockeye (not including Chignik) were 26.2 to 34.5. Those for

Kamchatka and Ozernaia Rivers were 25.8 and 24.7, respectively.

Fish of age 5_2. The mean value for Bristol Bay sockeye samples ranged from 19.0 to 24.4; and that for Kamchatka sockeye, from 14.8 to 15.2. There is a considerable overlap in the range of individual values between Asia and Alaska for this age group. The sample means for Chignik are 14.6 to 16.0, being approximately the same as for Kamchatka.

Fish of age 6_3. The sample means for Bristol Bay sockeye are 28.9 to 33.6, being considerably greater than the sample means of 20.7 to 22.8 for Kamchatka sockeye. The range of overlap in individual values is smaller than for age 5_3. Kamchatka samples have somewhat larger means than Chignik samples, but the frequency distributions of the two greatly overlap each other.

Fish of age 6_4. The only samples for this age group were those from the Ozernaia River collected in 1959 and 1960, their mean values being 28.1 and 29.1, respectively.

The above results indicate that the radius for the fresh-water period, which was used by Kubo (1958) and Kubo and Kosaka (1959) as a character to distinguish sockeye stocks for age groups 6_3 and 5_2, is an effective means to distinguish stocks also for other age groups (4_2, 5_3 and 6_4), as far as maturing fish are concerned.

2. Pink Salmon Scale Studies.

In 1961 a re-examination of the usefulness of scale characteristics for distinguishing stocks of pink salmon found on the high seas was made.

The following three measurements were taken for pink salmon scales collected from the Asian and North American coasts during 1956 to 1960.

(1) C_1: The number of circuli formed during the first year of life.

(2) C_b/C_a: The ratio between the number of circuli (C_a) included in the first half of the first year zone and that included in the second half of the first year zone (C_b).

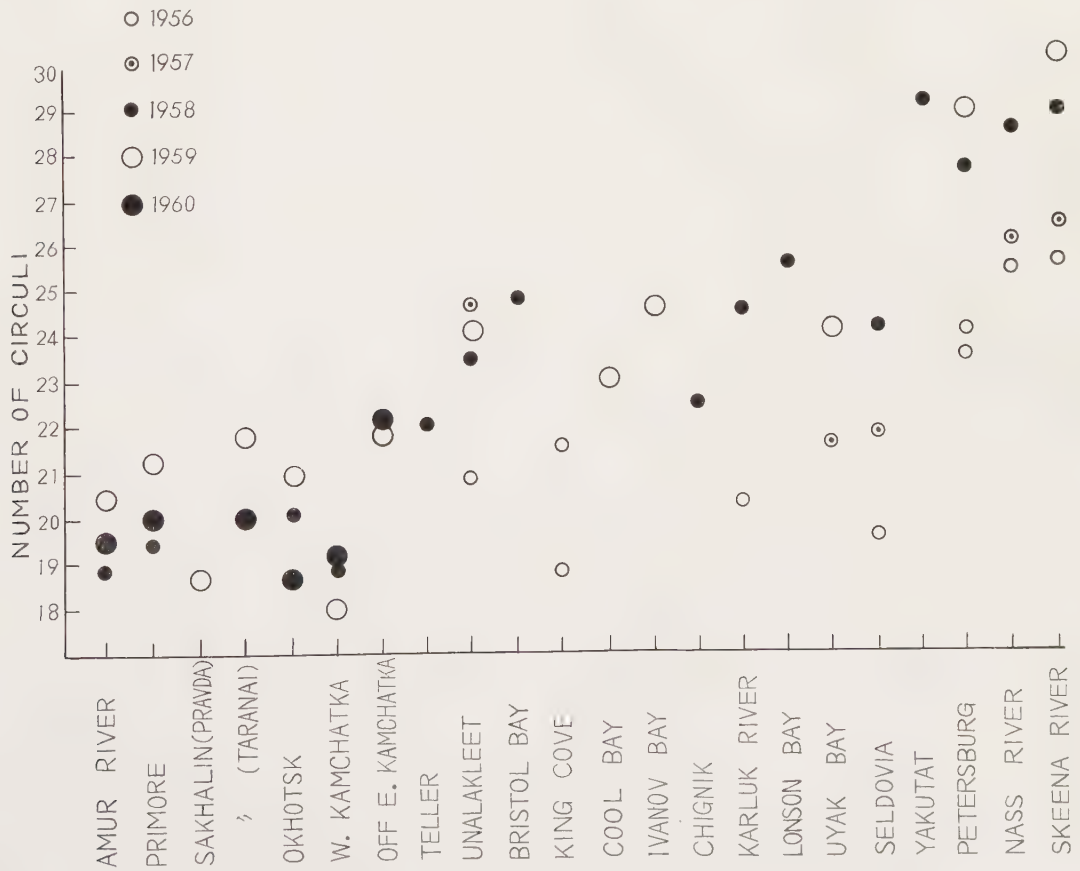

FIGURE 7. Mean value of the number of circuli formed in the first year (C_1).

(3) (C_1/R_1)x10: C_1 divided by the distance between the first circuli on the scale and the middle circuli of the first annulus (unit: 1/50 mm.) and multiplied by 10.

(In (1)–(3), measurement was made along the maximum radius from nucleus to the antero-dorsal edge of the scale.)

C_1 is a character that has been used for racial studies of pink salmon in offshore waters. In the present study, the measurement was made independently by a different worker; and the results were compared with those obtained previously. The results may be summarized as follows:

C_1: The mean values of C_1 are generally greater for North American stream and coastal samples than for Asian samples (Figure 7). Particularly high values are shown by samples from southern portions of the North American coast. The general trend of variation from area to area is similar to that reported by Ishida and Miyaguchi (1959) and Ishida (1961). Particularly, the average circulus counts for samples from the streams and coast of northern Asia are 18–22, being far smaller than those for North American samples.

C_b/C_a: As shown in Figure 8, the means of this ratio are generally smaller for the northern areas than for the southern areas of North America, although there is a considerable overlap between the northern and southern North American areas in the distribution of mean values.

(C_1/R_1)x10: The mean values of (C_1/R_1)x10 are generally low for samples from the northern streams and coast compared with those from the southern streams and coast of both Asia and North America (Figure 9). However, samples from the southern areas of North America, particularly the Nass and Skeena Rivers, have much greater mean values than other North American samples. For example, the mean values for the Nass and Skeena Rivers in 1958 are 6.36 and 6.55, respectively, while those for other areas are 5.66 or less. Similar results were obtained for the year 1959.

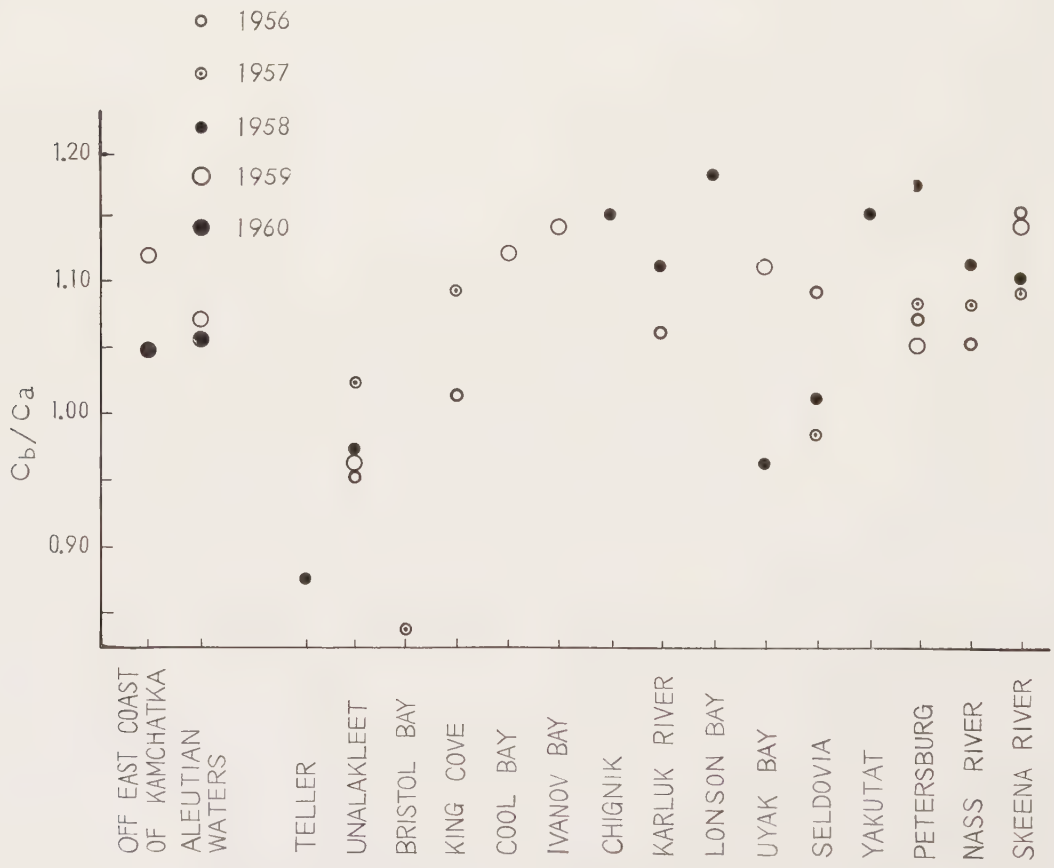

FIGURE 8. Mean value of C_b/C_a ratio of the samples from various rivers.

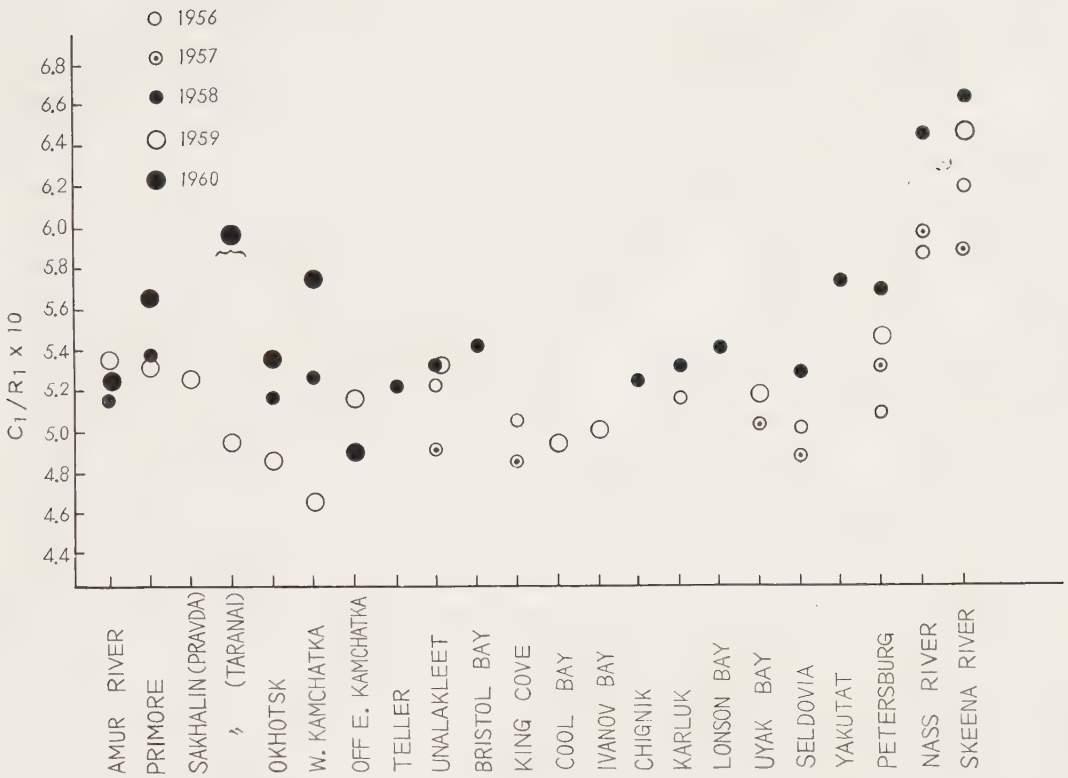

FIGURE 9. Mean value of C_1/R_1 ratio $\times$ 10 of the samples from various rivers.

Thus, it was revealed that there were significant differences in the scale characteristics of spawning pink salmon collected from the streams and coasts of different regions in the same year. Particularly, the value of C_1 is considerably smaller for pink salmon in northern Asia than for those in other areas; hence,

TABLE 9. Number of salmon released by area, by period and by vessel, 1961.

Area[1]	Vessel	Period	No. of tagging operations	Number of salmon released					
				Sockeye	Chum	Pink	Coho	Chinook	TOTAL
A	*Hokko-maru*	25 April–28 May	25	876	287	82	2	—	1247
B	*Takuyo-maru*	13 June–23 June	7	204	101	8	—	2	315
C	*Takuyo-maru*	1 Aug.–10 Aug.	9	168	394	1	9	13	585
D	*Wakashio-maru*	13 May–19 May	5	18	104	28	—	—	150
	Wakashio-maru	20 June–25 June	11	1	150	740	1	1	893
	Wakashio-maru	25 July–6 Aug.	6	—	222	72	99	—	393
	Takuyo-maru	19 May–8 June	14	339	308	91	—	1	739
	Takuyo-maru	27 July–1 Aug.	5	29	41	—	7	—	77
	Hokko-maru	3 June–10 June	5	424	94	4	—	—	522
	Sub-total, Area D		46	811	919	935	107	2	2774
E	*Wakashio-maru*	29 April–11 May	11	—	57	556	—	—	613
	Wakashio-maru	2 June–18 June	13	7	152	833	—	1	993
	Sub-total, Area E		24	7	209	1389	—	1	1606
GRAND TOTAL			111	2066	1910	2415	118	18	6527

[1] See Figure 10.

this character is considered useful for determining the origin of pink salmon found in offshore waters. Another character, $(C_1/R_1)x10$, also shows very much higher values for pinks from the southern part of the North American coast, particularly the streams of British Columbia, than for those from other areas. Accordingly, it may be possible to distinguish pink salmon bound for this region from other pink salmon caught on the high seas by using this character.

C. Tagging Experiments

Tagging in 1961 was conducted by the *Hokko-maru* of the Ministry of Agriculture and Forestry (220 g.t., 550 h.p.), *Takuyo-maru* (chartered vessel; 172 g.t., 320 h.p.) and *Wakashio-maru* (chartered vessel; 153 g.t., 320 h.p.) in the North Pacific Ocean by using long-lines for catching salmon, as in previous years.

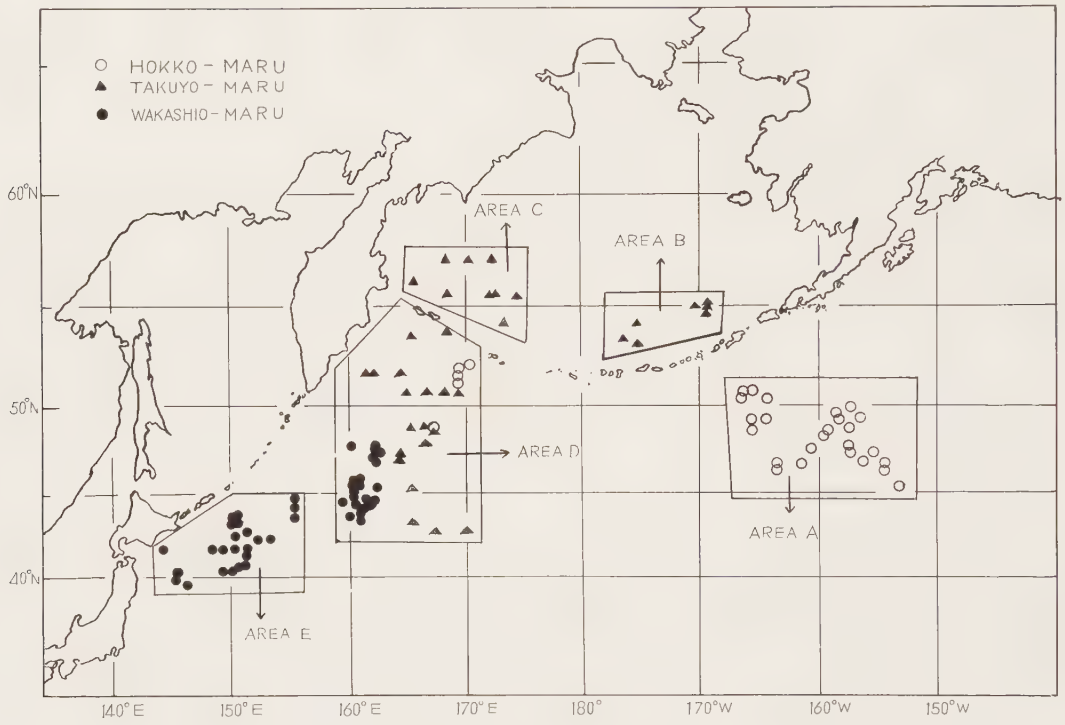

Figure. 10. Tagging locations in 1961. ○-*Hokko-maru*; ▲-*Takuyo-maru*; ●-*Wakashio-maru*.

As shown in Table 9 and Figure 10, an attempt was made to tag salmon in waters south of Kodiak Island during late April through late May. Tagging in this area during this period of the season had not been done in previous years. It had been assumed, from the results of previous tagging experiments, that salmon bound for streams along the Bering Sea coast and some of the Hokkaido autumn chums spent the winter and early spring in this general region. This year's experiments were designed to prove this hypothesis.

Table 9 gives the numbers of fish tagged by regions (waters of the North Pacific and Bering Sea are divided as shown in Figure 10) and periods. For the entire season and all areas of tagging, approximately equal numbers of sockeye, chum and pink salmon were tagged. It is noted that only small numbers of pink salmon were caught in the region south of Kodiak Island (Region A); hence, the attempt to tag sufficient numbers of salmon in this region failed, as far as pink salmon were concerned. However, some valuable information was obtained, from tagging in Regions A and E, regarding the distribution and migration of Bristol Bay sockeye and Amur River chums (particularly autumn chums as mentioned below).

Figure 11 gives the fork length composition of the sockeye and chum salmon tagged by the *Hokko-maru* and *Takuyo-maru*, which occupied waters of the North Pacific Ocean excluding those off Hokkaido and the Kuriles (south of 48°N.). Sockeye salmon tagged in Region D have higher proportions of larger fish than those tagged in Region A. Such difference is associated not only with the difference in the period

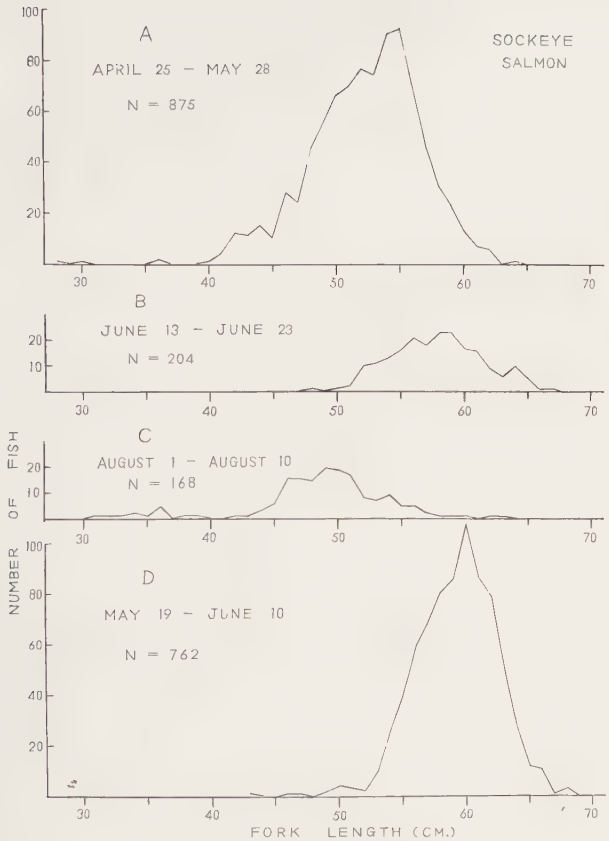

FIGURE 11 (a). Length composition of sockeye salmon tagged by the *Hokko-maru* and *Takuyo-maru* in 1961. (Fork length —both sexes combined; A–D indicate areas of tagging.)

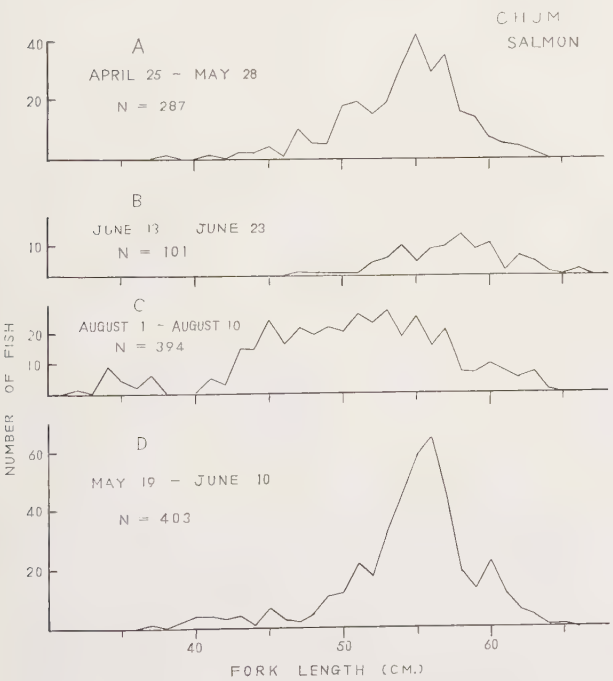

FIGURE 11 (b). Length composition of chum salmon tagged by the *Hokko-maru* and *Takuyo-maru* in 1961. (Fork length —both sexes combined; A–D indicate areas of tagging.)

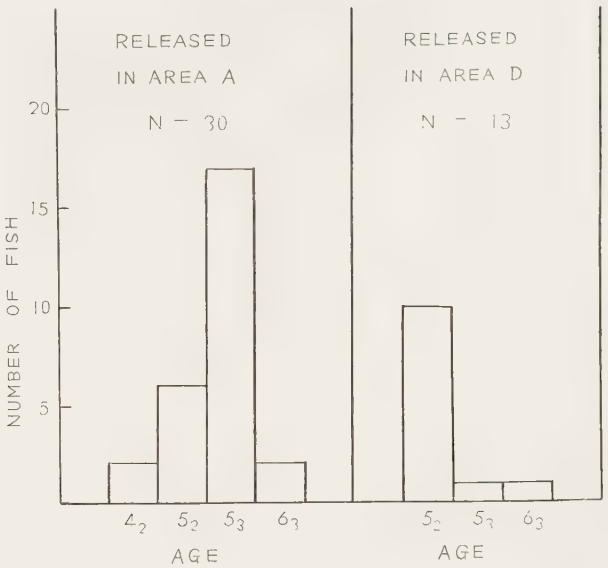

FIGURE 12. Age composition of sockeye salmon released in Areas A and D in 1961 and recaptured in Bristol Bay.

of tagging but also with that in age composition. As shown in Table 10, fish having spent two winters in the ocean (ages 4_2 and 5_3) predominated in Region A, while those having spent three winters in the ocean (ages 5_2 and 6_3) predominated in Region D.

1. Recoveries.

The following summary is based on the recoveries reported up to January 25, 1962. Data include all recoveries that have been reported in 1961 and the recoveries in the U.S.S.R. and Hokkaido during 1960 from tagging in 1960 (part of them were reported in the research summary for 1960). These recoveries are summarized in Tables 11–13 and Figures 13–22.

Sockeye salmon (Figures 13 and 14): Approximately 70% (or 876 fish) tagged in Region A were sockeye. A total of 44 recoveries was made, of which 30 were from Bristol Bay. Of the remainder of 11 recoveries, five were from southeastern Alaska and British Columbia, and six from the high seas. One of the six high seas recoveries was from an area close to East Kamchatka (tagged May 9 at 48°29′N.x-159°10′W.; recaptured on July 2 at 50°47′N.x-162°29′E.; length at tagging 55.0 cm.; length at recapture 68.0 cm.; age 6_3), but it is not appropriate to discuss the migration of sockeye salmon on the basis of this single recovery.

At any rate, it is obvious that most of the sockeye found in Region A during this period were Bristol Bay fish but smaller numbers of sockeye bound for

TABLE 10. Principal age composition of sockeye salmon tagged in Areas A and D, 1961.

Area	Age						
	4_2	5_2	5_3	6_3	Other age groups	Age indeterminable	TOTAL
A	14.3 (%)	27.7	35.5	7.6	3.0	11.9	100 (%)
	125	243	311	67	26	104	876
D	2.0 (%)	40.0	6.7	34.9	3.1	13.3	100 (%)
	16	325	54	283	25	108	811

TABLE 11. Recaptures[1] from 1961 tagging by area of release, as of January 25, 1962.

Area	Species	High seas		Coastal areas and streams								
		N. Pac. Ocean	South of 48°N.	Kotzebue	Yukon	Bristol Bay	S. E. Alaska	Kodiak	B. C.	U.S.S.R.[2]	Hokkaido	TOTAL
A	Sockeye	6				32[3]	4	1	1			44
	Chum	3								(3)	3[4]	9
	Pink						1					1
	TOTAL	9				32	5	1	1	3	3	54
B	Sockeye	1				55						56
	Chum			3	1						5	9
	Pink											
	TOTAL	1		3	1	55					5	65
C	Sockeye											
	Chum										6	6
	Pink											
	TOTAL										6	6
D	Sockeye	72	1			13				4		90
	Chum	13	2							2 (9)		26
	Pink	3	5							2	1	11
	Coho		2									2
	TOTAL	88	10			13				17	1	129
E	Sockeye		1									1
	Chum		2							8 (4)		14
	Pink		45							4		49
	Chinook										1	1
	TOTAL		48							16	1	65
TOTAL	Sockeye	79	2			100	4	1	1	4		191
	Chum	16	3	3	1					10 (16)	15	64
	Pink	3	50				1			6	1	61
	Coho		2									2
	Chinook										1	1
	TOTAL	98	57	3	1	100	5	1	1	36	17	319

[1] Including recaptures by research vessels.

[2] Figures in parentheses indicate recaptures as summer-run.

[3] Including recaptures in Unimak Island and south side of Alaska Peninsula.

[4] Including recaptures in South Sakhalin Island.

southeastern Alaska and British Columbia were also present.

In 1961, 13 sockeye salmon tagged in the northern part of Region D were recaptured in Bristol Bay. The presence of Bristol Bay salmon in this area has been indicated by previous tagging experiments. It should be noted, however, that the westernmost

TABLE 12. Recaptures in U.S.S.R. and Hokkaido in 1961 from 1961 tagging, by area of release.

Area	Species	Coastal areas and streams U.S.S.R.[1]	Hokkaido	TOTAL
	Chum	(1)	1	2
B	Pink	1		1
	TOTAL	2	1	3
E	Chum		1	1
	TOTAL		1	1
	Chum	5	1[2]	6
G	Pink	3	1	4
	TOTAL	8	2	10
	Chum	2 (5)	1[2]	8
H	Pink	1		1
	TOTAL	8	1	9
	Chum	13	4	17
TOTAL	Pink	5	1	6
	TOTAL	18	5	23

[1] Figures in parentheses indicate recaptures as summer-run.
[2] Recapture in South Sakhalin Island.

TABLE 13 (a). Recaptures in 1960 of salmon tagged in 1960, by area of release.

Area	Species	High seas North Pacific Ocean	High seas South of 48°N.	Coastal areas and streams U.S.S.R.	Coastal areas and streams Bristol Bay	TOTAL
	Sockeye	1				1
A	Chum	2		1		3
	TOTAL	3		1		4
	Sockeye	2				2
D	Chum	1		1		2
	TOTAL	3		1		4
	Sockeye	1			2	3
E	Chum		1			1
	TOTAL	1	1		2	4
I	Sockeye	1				1
	TOTAL	1				1
	Sockeye	5			2	7
TOTAL	Chum	3	1	2		6
	TOTAL	8	1	2	2	13

TABLE 13 (b). Recaptures in 1961 of salmon tagged in 1959, by area of release.

Area	Species	North Pacific Ocean	South of 48°N.	Hokkaido	TOTAL
B	Chum	1		1	2
E	Chum		1		1

location of tagging for Bristol Bay sockeye salmon in 1961 was considerably more westerly than that for previous years. The relationship between Bristol Bay salmon found in Region A and those found in Region D is discussed below.

As already mentioned, sockeye salmon tagged in Region A were quite different in age composition from those tagged in Region D. This indicates that these sockeye belonged to different groups, even though the period of tagging was different between the two regions. However, since it is obvious that sockeye in these two regions included fish bound for areas other than Bristol Bay, it is not appropriate to use the age composition of all fish tagged for comparison. Therefore, the age composition of the sockeye salmon actually recaptured in Bristol Bay was compared between these two regions of tagging (Figure 12). Among the 30 sockeye tagged in Region A and recaptured in Bristol Bay, 17 were age 5_3, six were 5_2, two were 6_3, two were 4_2, and the age was unknown for the remaining three. Of the 13 sockeye tagged in Region D and recaptured in Bristol Bay, 10 were age 5_2, one was 5_3, one was 6_3, and one was of unknown age. In short, tagging results indicated that in 1961 the sockeye salmon moving from Region A to Bristol Bay were strongly represented by fish of age 5_3; while those moving from Region D to Bristol Bay by fish of age 5_2. Therefore, we can consider that Bristol Bay sockeye tagged in Region A and those tagged in Region D belonged to separate concentrations.

It is not certain as yet whether sockeye salmon of higher ocean ages (5_2 in the case of 1961) tend to winter in waters farther away from the spawning grounds than those of lower ocean ages, or whether the former fish begin migration earlier in the spring than the latter fish after wintering in the same general waters. The answer to this question must await further studies. It is nevertheless obvious that these sockeye salmon found in waters south of Kodiak Island must be taken into consideration in answering various questions regarding the oceanic life of Bristol Bay sockeye salmon.

Chum salmon (Figures 15 to 19): The tagging experiments conducted in waters of the North Pacific Ocean east of 160°E. up to 1959 did not give any direct information as to the offshore distribution and migration of summer and autumn chum salmon bound for the Amur area. Japan has operated, since 1960, one research vessel exclusively for tagging in waters east of Hokkaido and the Kurile Islands and south of 48°N., principally for the purpose of learning the

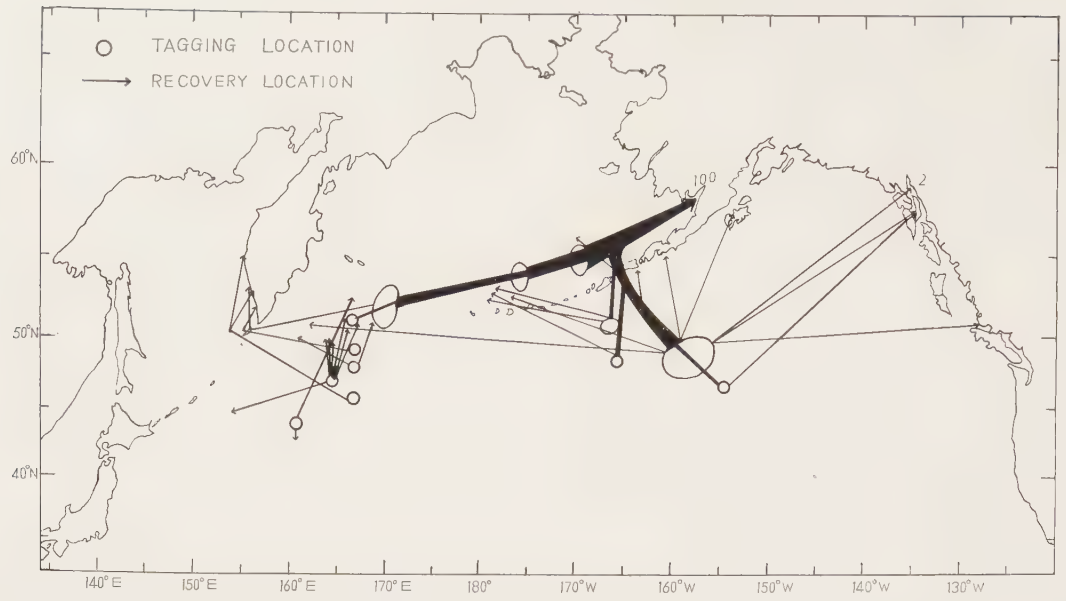

FIGURE 13. Sockeye salmon tagged in 1961 and recaptured in 1961, as of January 25, 1962. (Figures at ends of lines indicate number of fish recaptured in the same areas.) Note: Recaptures on high seas showed only typical recaptures.

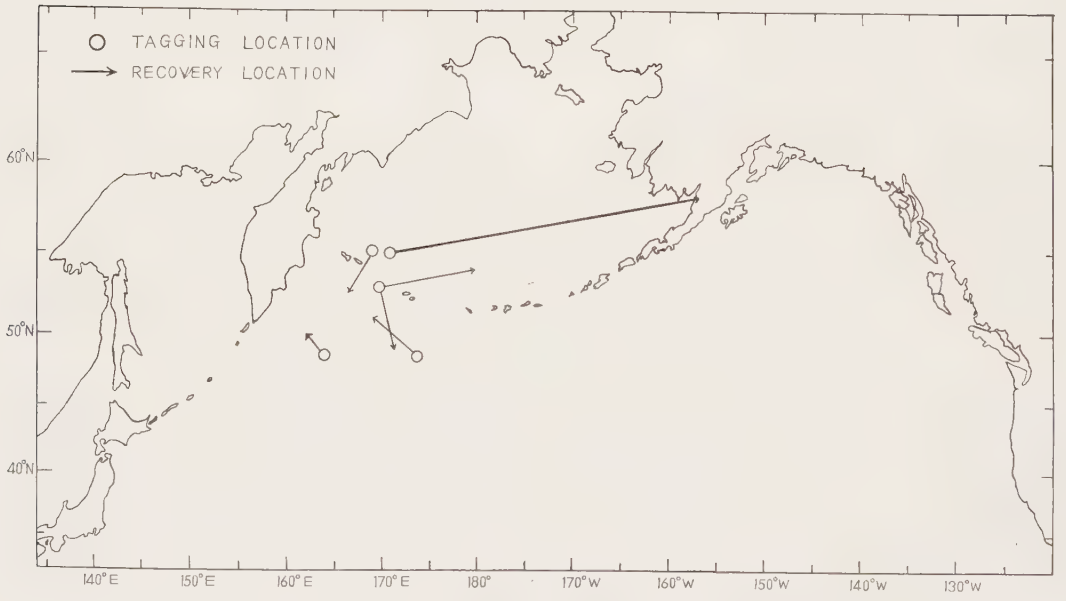

FIGURE 14. Sockeye salmon tagged in 1960 and recaptured in 1961.

relationship between pink salmon found in these offshore waters and those found along the various coasts of the Far East.

The results of these experiments have revealed that chum salmon found in these offshore waters (Region E in 1961) consist mainly of autumn and summer chums bound for the Amur area and chum salmon bound for the northern coast of the Okhotsk Sea. Particularly noticeable was the predominance of Amur autumn chums (in 1960, seven out of 15 coastal and stream recoveries during the year of tagging; and in 1961, eight out of 12). Although this information coincides with our assumption from the numbers of chum salmon with longline hooks, the direct evidence obtained from tagging is a great

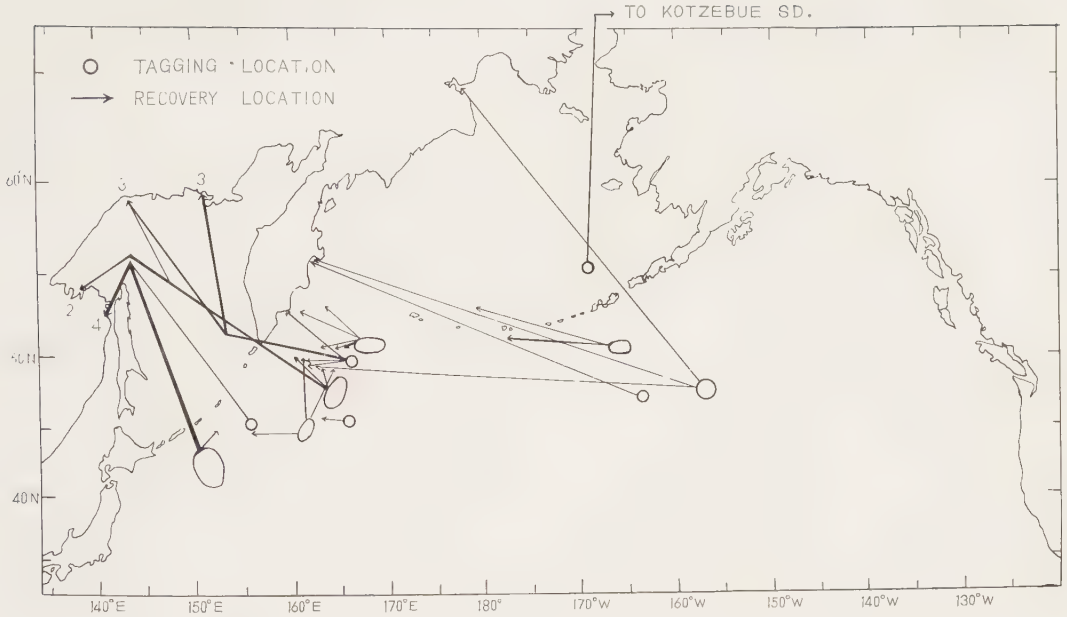

FIGURE 15(a). Summer-run chum salmon tagged in 1961 and recaptured in 1961 (including recaptures on high seas).

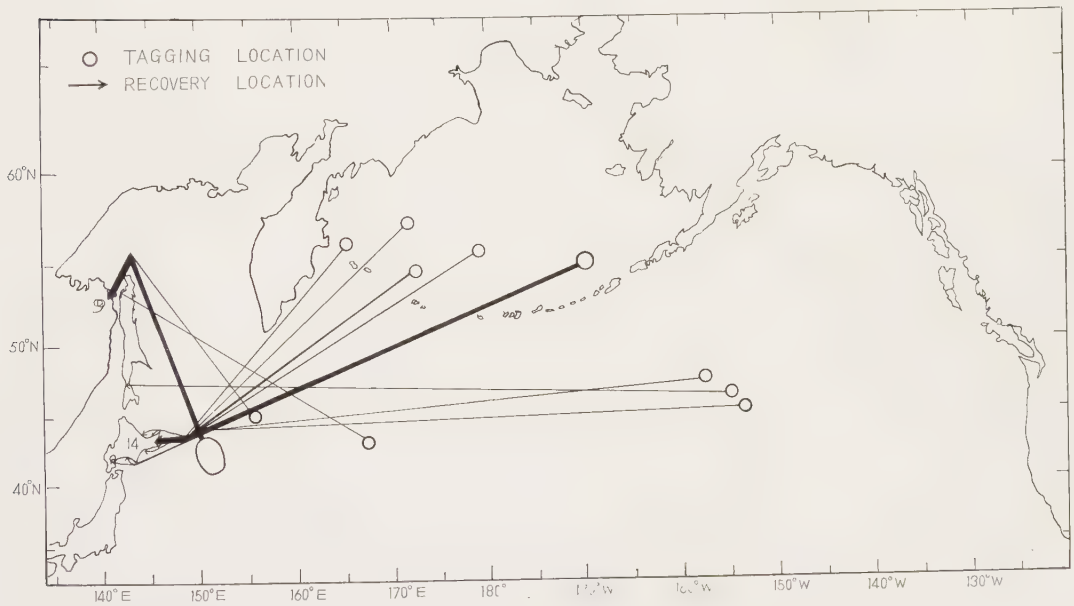

FIGURE 15(b). Autumn-run chum salmon tagged in 1961 and recaptured in 1961.

contribution to our knowledge of the offshore distribution of chum salmon, which will be very useful in conducting future investigations.

As is widely known, vigorous efforts were made to tag salmon in Kurile waters during the pre-war years. Comparing the results from these pre-war experiments (Hirano, 1953) with those from the post-war experiments, a remarkable general similarity is found, except for the fact that chum salmon found in great abundance in waters close to the Pacific coast of Hokkaido in the pre-war years (called " toki-shirazu " and assumed to be Amur chums by Hirano) are no longer present in any appreciable quantities. Thus, it appears that the boundary between waters occupied mainly by chum salmon bound for the

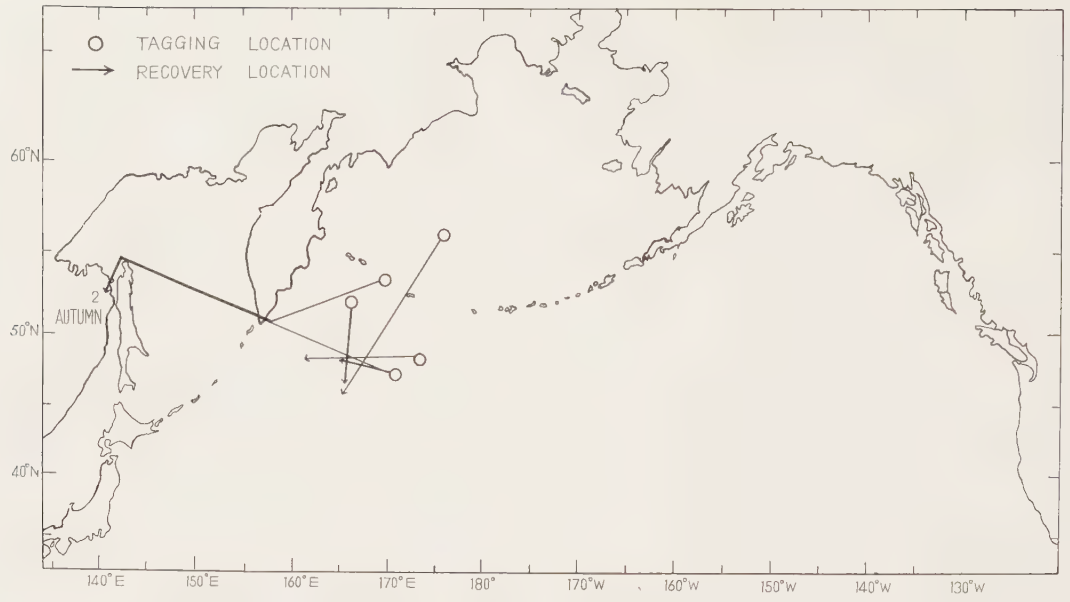

FIGURE 16. Chum salmon tagged in 1960 and recaptured in 1961.

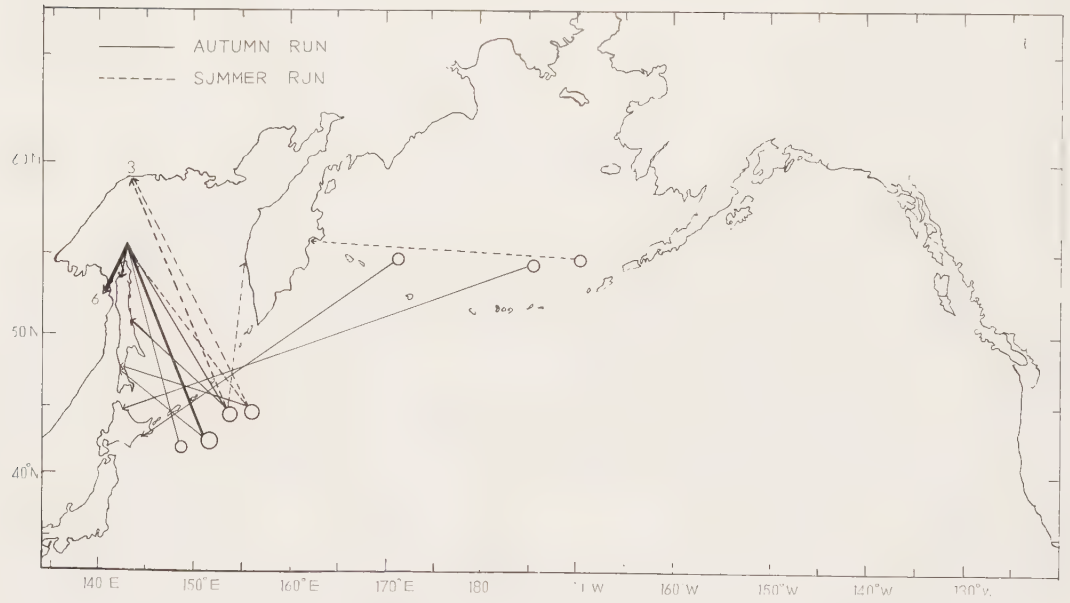

FIGURE 17. Chum salmon tagged in 1960 and recaptured in the U.S.S.R. and Hokkaido in 1960.

Amur area, Sakhalin and the western part of the northern coast of the Okhotsk Sea and those occupied mainly by chum salmon bound for West Kamchatka and the central and eastern parts of the northern coast of the Okhotsk Sea is found, on the Pacific side of the Kurile chain, in waters off the central Kurile Islands. The spawning areas of these two groups of chum salmon, which have separate distribution areas off the Kurile Islands, overlap geographically at their extremities in the western region of the northern coast of the Okhotsk Sea. However, the numbers of recoveries from various coastal areas other than the Amur and Hokkaido are not sufficient to determine the distribution of chum salmon bound for the different areas of the Far Eastern coast facing the Okhotsk Sea. Also, more detailed discussion of the distribution and migration of Amur autumn chums cannot be undertaken in this report, because analysis

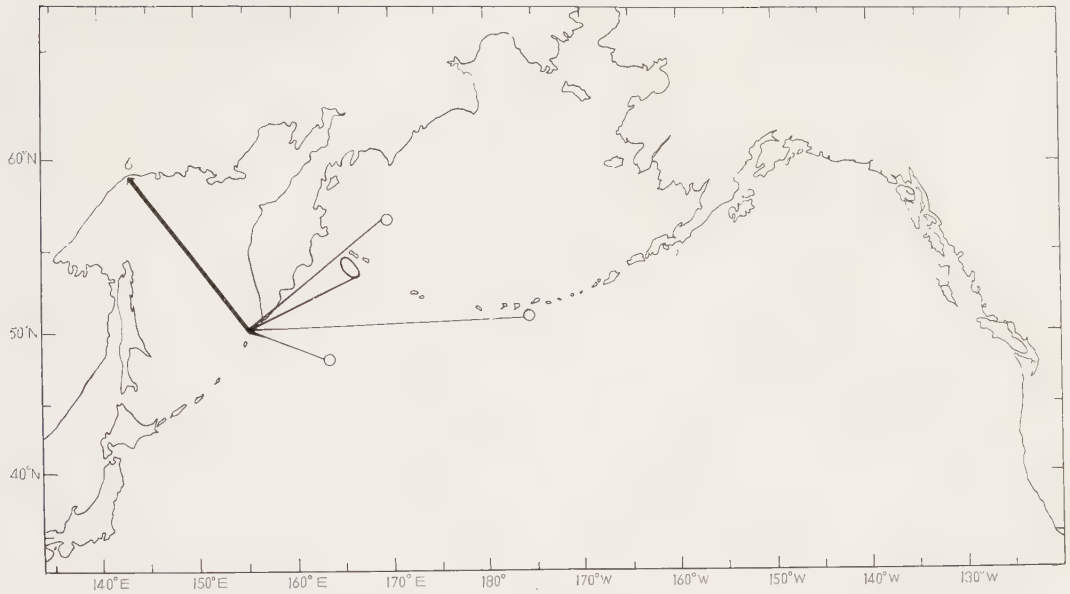

FIGURE 18. Chum salmon tagged in 1959 and recaptured in the U.S.S.R. and Hokkaido in 1960.

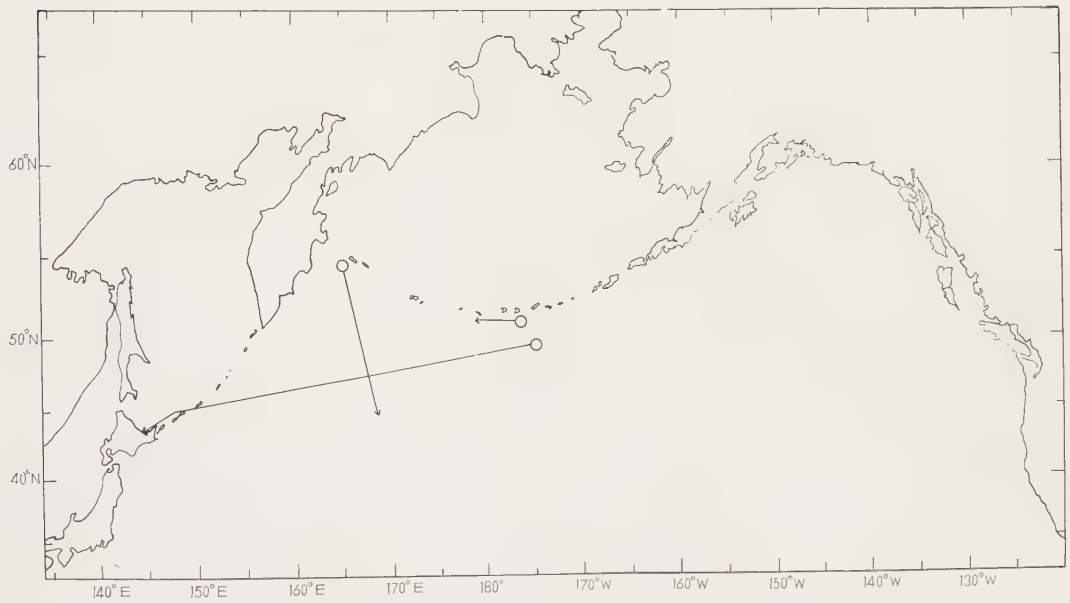

FIGURE 19. Chum salmon tagged in 1959 and recaptured in 1961.

of the data has not been completed.

The recoveries of summer chum salmon in the Anadyr and Kamchatka River areas and those of autumn chum salmon in Hokkaido and Sakhalin from tagging in Region A in 1961 [Figures 15(a) and (b)] support the hypothesis mentioned previously. The information on the distribution and migration of chum salmon bound for the various districts between Anadyr and Sakhalin is still not as accurate as the information on sockeye and pink salmon.

Pink salmon (Figures 20 and 21): From tagging in waters off the east coast of Hokkaido and the Kuriles (south of 48°N.), one recovery each (a total of four) was reported from the eastern, central and western parts of the northern coast of the Okhotsk Sea and from the Okhotsk coast of Hokkaido in 1960; and

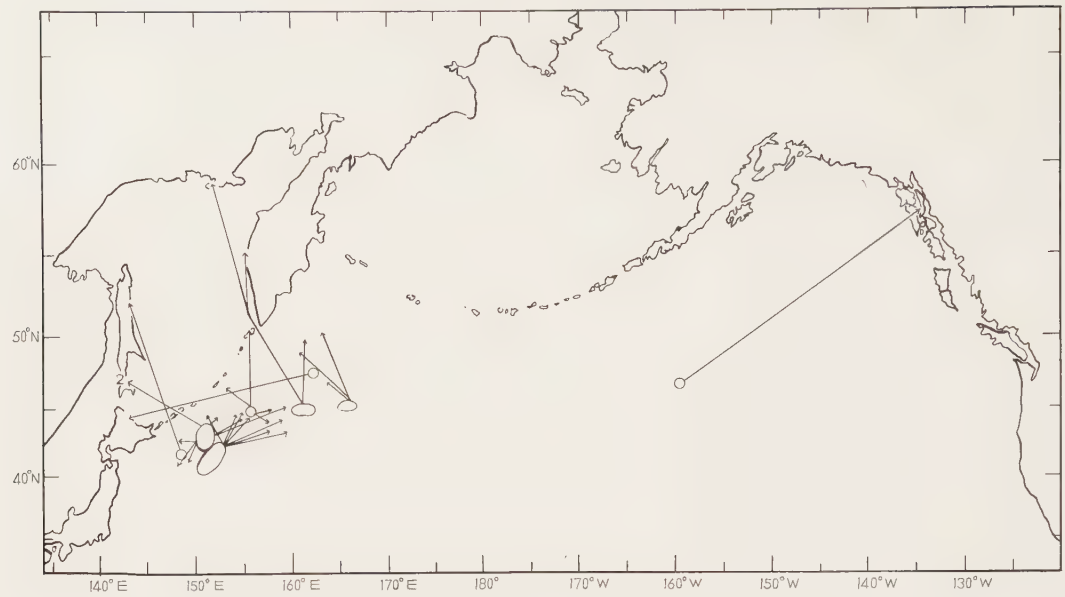

FIGURE 20. Pink salmon tagged in 1961 and recaptured in 1961.

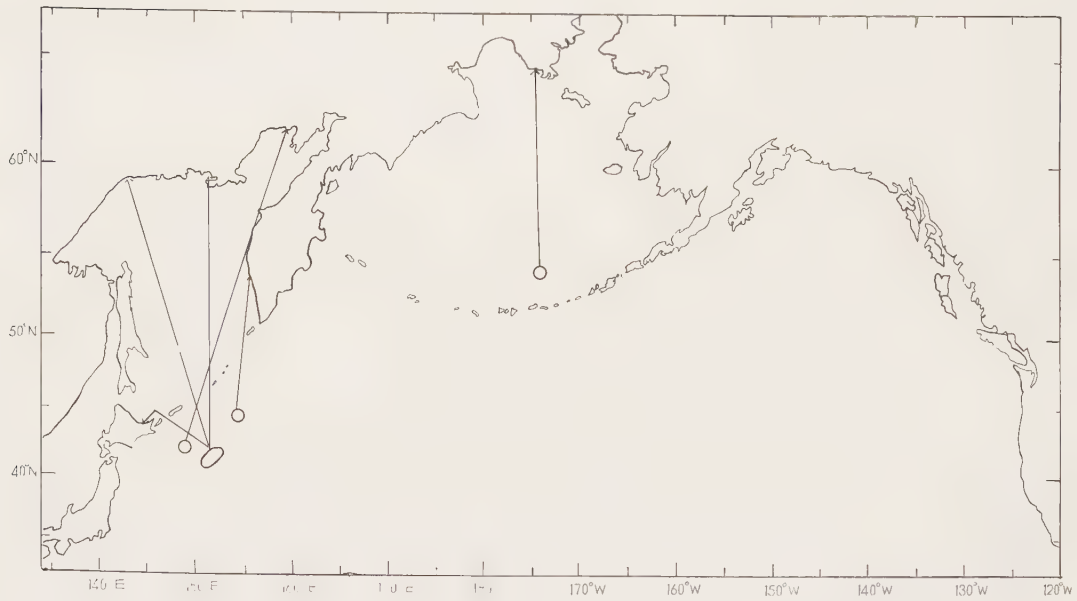

FIGURE 21. Pink salmon tagged in 1960 and recaptured in the U.S.S.R. and Hokkaido in 1960.

three from Sakhalin, one from the central part of the northern coast of the Okhotsk Sea, one from West Kamchatka and one from the Okhotsk Sea coast of Hokkaido (a total of six) in 1961. It is difficult to discuss the relationship between pink salmon found in these offshore waters and those migrating into the rivers of the various districts of the Okhotsk Sea coast from such scanty data.

One pink salmon tagged in Region A in 1961 was recaptured in southeastern Alaska (Pybus Bay), thus adding a new example to our tagging results.

D. Oceanography

As in previous years, the *Oshoro-maru*, a training vessel of the Department of Fisheries, Hokkaido

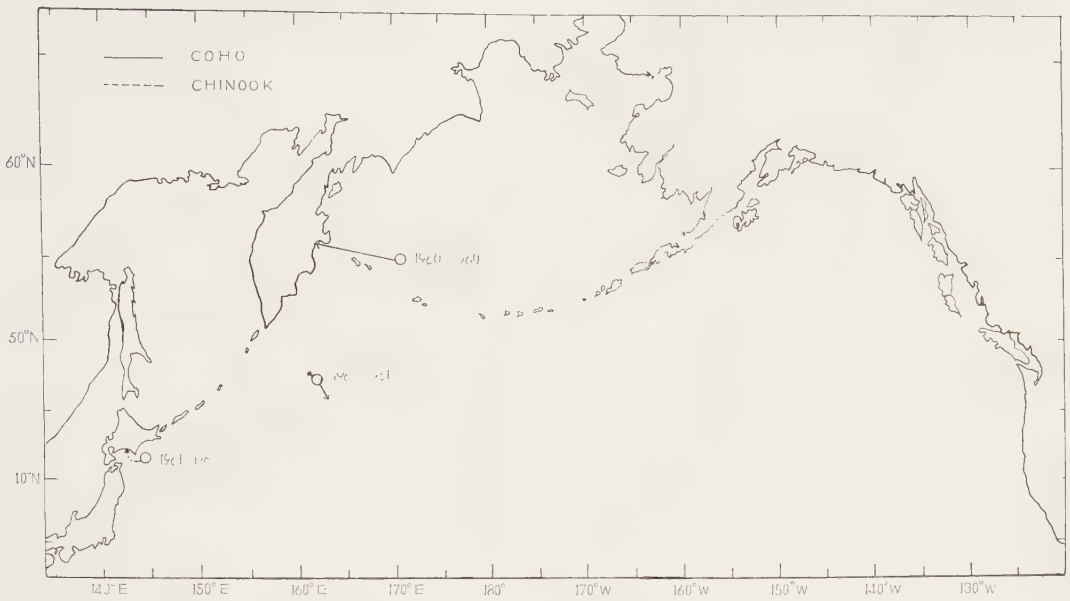

FIGURE 22. Coho and chinook salmon tagged in 1961 and recaptured in 1961.

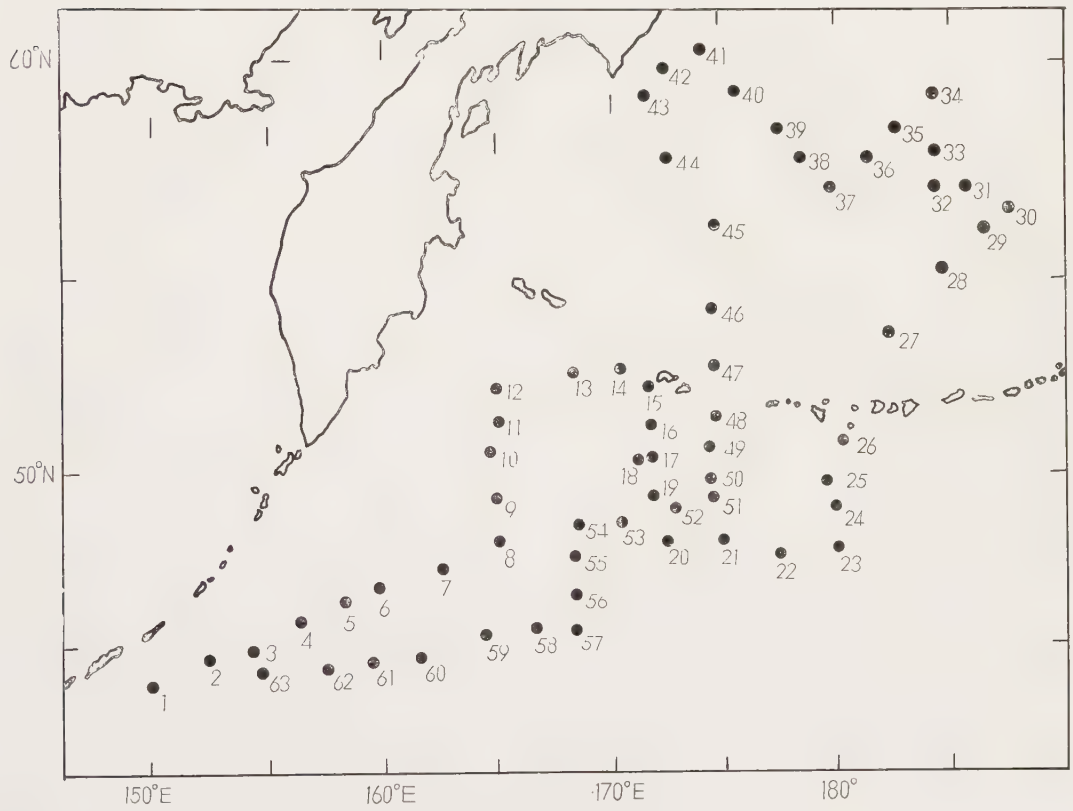

FIGURE 23. Stations occupied by the *Oshoro-maru* during June-July, 1961.

University, conducted oceanographic investigations in the northern Pacific Ocean, Aleutian waters and the Bering Sea. The 63 stations shown in Figure 23 were occupied during the period from June 14 to July 22. Temperature observations were made and water samples were taken at depths of 0, 10, 20, 30,

50, 75, 100, 150, 200, 300, 400, 500, 600, 800, 1,000, 1,200, and 1,500 meters.

Plankton sampling was carried out at each of the above stations by using the North Pacific standard plankton net for a vertical tow from 100 meters to the surface and a phytoplankton net in a vertical tow from 100 meters to the surface and multi-layer horizontal tows (sampling to a depth of 1800 meters was carried out at two stations).

The collection of larvae was carried out at 36 stations by towing a larval net for 10 minutes immediately after sunset.

The data obtained are being compiled by a group of oceanographers.

II. REPORT ON KING CRAB RESEARCH IN THE EASTERN BERING SEA

The Japanese king crab fishery during the spring of 1961 was carried out on the same scale as in 1960 and the same quantity of canned crab was produced. The mothership *Tokei-maru* (5,385 g.t.) arrived on the fishing grounds on April 10, and left the grounds after packing 80,000 cases (48½-lb. cans per case) on July 2. Three independent vessels (60 to 80 g.t.) and eight deck-loaded boats were used for fishing. Another crab mothership, the *Shinyo-maru*, operated in the Bering Sea (not only for crabs but also for other species). The amount of king crab caught by this mothership was equivalent to 20,000 cases of canned crab.

The king crab investigations by Japan were carried out by a biologist aboard the crab mothership *Tokei-maru*, as in previous years. In addition to the collection of commercial fishing data as in previous years, emphasis was placed, in 1961, on observations of various phenomena related to the moulting of adult females and of the moulting, growth and regeneration of walking legs of juvenile crabs.

A. Collection and Analysis of Commercial Fishing Data

1. An Outline of Fishing Operations.

Fishing in 1961 was conducted on the five fishing grounds shown in Figure 24. Table 14 gives the results of fishing on each of these grounds. A total of approximately 1.5 million crabs was caught, one-third and two-thirds of which were obtained from the Amak and Port Moller areas, respectively. The catch per tan of (tangle) net was, in general, slightly lower than in previous years, particularly during the earliest part of the season. This was, however, offset by a smaller average number of crabs required for packing one case during the early part of the season, resulting in a relatively good fishing season. The seasonal average pack per tan of net was 0.69 cases and was slightly lower than in 1959 and 1960, when

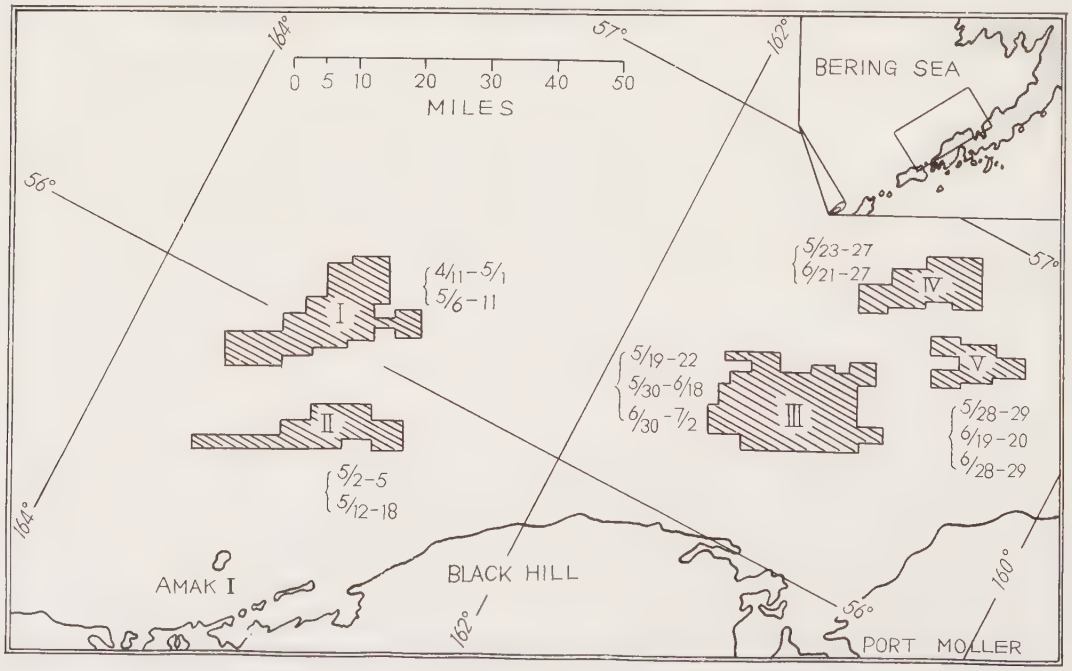

Figure 24. King crab fishing areas I–V, *Tokei-maru*, 1961 spring season.

TABLE 14. Summary of fishing operation by *Tokei-maru*[1], 1961 spring season.

Month	Catch (in no. of crabs)	No. of tans hauled	Catch per tan	No. of cases[2] packed	No. of crabs per case
April	243,190	22,569	10.8	14,599	15.9
May	564,440	45,014	12.5	31,299	18.1
June	679,520	44,593	15.2	32,127	21.0
July	37,430	3,224	11.6	1,975	24.9
TOTAL	1,524,580	115,400	13.2	80,000	19.1

[1] 5,386 g.t. ; three independent fishing vessels ; eight catcher boats ; period of operation, April 11 to July 3.
[2] 24 lbs. per case.

fishing was better than average, but was higher than in the years up to 1958. The high average number of crabs required for packing one case observed in the Port Moller area resulted from larger proportions of so-called " very old " crabs. Their muscle tissue was partly degenerated and the amount of available meat was small. Hence, only " flakes " were made from these crabs. Figure 25 shows year-to-year changes in the spring crab fishery in the Bering Sea (*Tokei-maru* data only). The average catch per tan has varied, but has shown a general trend of increase[1]. The average number of crabs required for packing one case has been virtually unchanged during the above period, being 19–20. The average carapace length of crabs used for packing gradually decreased from 170 mm. in 1953 to 159 mm. in 1958 and has fluctuated thereafter around a level of 160 mm.

[1] It should be noted, however, that the average length of time the nets have soaked has also increased steadily.

2. Catch Composition.

Crabs caught are usually divided into five categories: "males", "new shelled males", "under-sized males", "females" and "tanner crabs". Among king crabs of the four categories, only those of the first category are used for packing. The abundance of crabs of different categories can be determined from the results of test-net fishing. For the purpose of scouting crab concentrations, test nets are set in areas considerably wider than those covered by ordinary nets. Also, these nets are hauled after being soaked

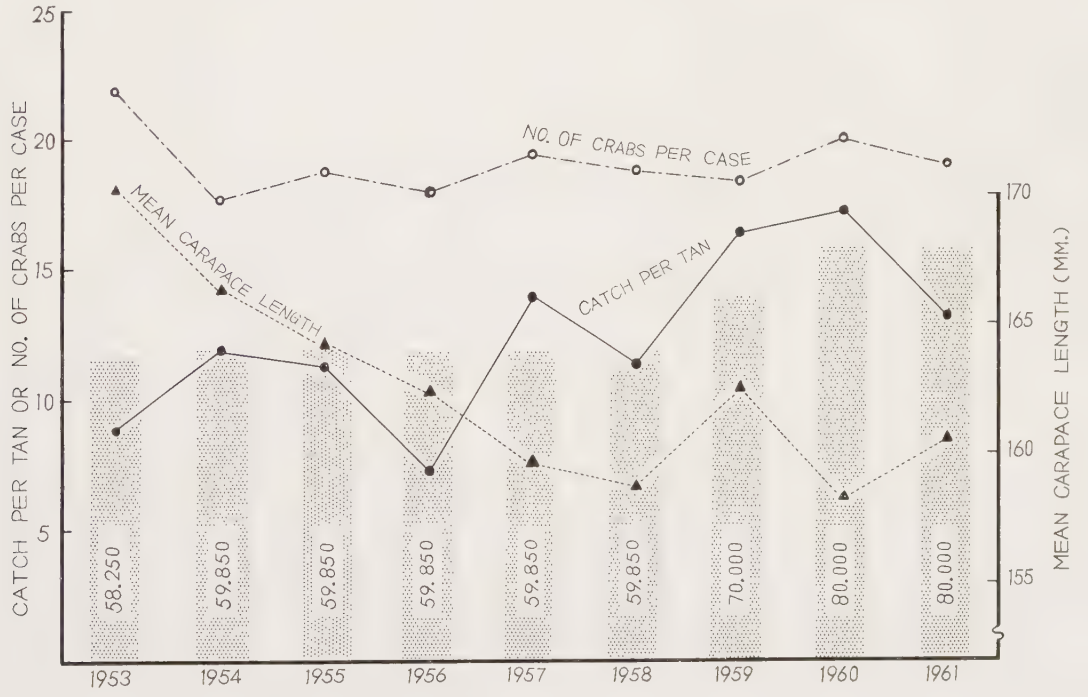

FIGURE 25. Catch per tan, number of crabs per case, the mean carapace length of commercial crabs, and the total annual production in cases (histogram), *Tokei-maru*, 1953–1961.

Table 15. Records of fishing by scouting nets, 1961 spring season.

Fishing areas	Periods of operation	No. of sets	No. of tans hauled	No. of crabs caught	Total catch composition (%)				
					Males	New-shelled males	Under-sized males	Females	Tanner crabs
Amak									
Inshore	Apr. 19–May 3	74	355	4,656	31.1	1.5	1.1	12.0	54.3
Offshore	Apr. 11–25	172	850	10,628	37.6	0.8	1.3	7.3	53.0
Black Hill	Apr. 25–26	20	100	631	36.8	2.9	0.8	7.0	52.5
Port Moller									
Inshore	May 7–June 5	91	447	10,857	45.5	0.9	6.5	18.9	28.2
Offshore	May 17–June 2	89	530	11,738	46.2	1.0	6.9	36.5	9.4
Total		446	2,282	38,510	41.6	1.1	4.4	20.0	32.9

for only 12–24 hours, although they are occasionally left in the water for as long as three to four days. The composition of the catch is recorded for each set. It should be mentioned, however, that since the test nets are also tangle nets, the composition of the test-net catches is affected by the selectivity inherent in this type of gear.

According to the catch data from test-net fishing, there are characteristic differences in catch composition between waters from off Amak Island to off Black Hill and those off Port Moller (Table 15). First, the proportion of females is higher in the latter; secondly, the proportion of tanner crabs is much higher in the former.

Figure 26 indicates year-to-year variations in the categories of crabs caught by test nets. A most remarkable tendency is that of a decrease in the proportion of hard-shelled male king crabs and an increase in the proportion of tanner crabs since 1958. This is perhaps the result of more test-net fishing in recent years in waters where tanner crabs are abundant. Sixty percent of the test-net fishing in the spring of 1961 was carried out in the Amak area.

Figure 26. Percentages of males (M), new-shelled males (NM), under-sized males (UM), females (F), and tanner crabs (T), 1955–1961. Data are based on scouting net catches.

Random sampling of commercial catches for measuring carapace length was carried out on a daily basis. As many crabs as possible were measured for carapace length and carapace width, weight was recorded for 40 specimens a day. The number of crabs used for carapace length measurement totalled 51,797, of which about 70 percent were from the Amak area and the remainder from the Port Moller area. The carapace length of crabs used for canning ranged from 120 mm. (130 mm. in carapace width) to 200 mm. (Figure 27). Those from the Amak area consisted of crabs of two categories, larger and smaller, with a dividing length at approximately 150 mm. In the Port Moller area, practically only larger crabs were used. Some of the larger crabs were very old.

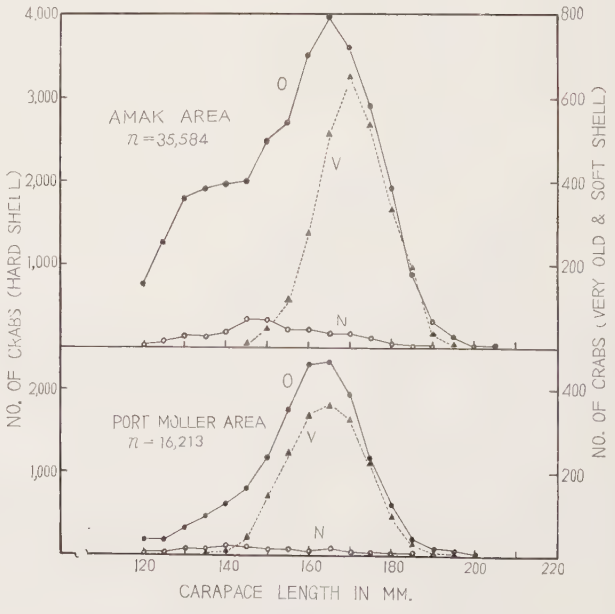

Figure 27. Frequency distribution of carapace length for samples from commercial catches by *Tokei-maru* in 1961 spring season. N = new shell, O = old shell, V = very old shell.

Crabs with shells in incomplete post-moult calcification were present, in small numbers, in almost all carapace-length classes, except in classes of extremely large carapace lengths. However, crabs with too soft shells were not landed onto the mothership, because they were not suitable for canning.

3. Distribution and Movements of Male Crab Schools.

The distribution chart for male crabs was made based on test-net catch data. Test-net fishing was carried out from April 11 to June 5. The distribution chart was drawn for the periods April 11 to April 13, April 16 to April 23, April 24 to April 25 and May 7 to May 19, and May 24 to June 5, respectively. Three centers of distribution were recognized in the Amak area during the period April 11 to 13. The catch per day per tan in these centers of concentration was over 15, except for lower catches from school I (5 to 10 per day per tan) (see Figure 28). As shown in Figure 28, the movements of the three schools during the month of April may be inferred from the shift of their centers. However, the relationships between different schools observed during different periods may be subject to some doubt. It is desirable to confirm the findings from catch data by tagging experiments. Test-net fishing after the month of April was conducted exclusively in the Port Moller area, and three centers of distribution were recognized. Insofar as the distribution chart is indicative, these three schools did not make noticeable movements until early June.

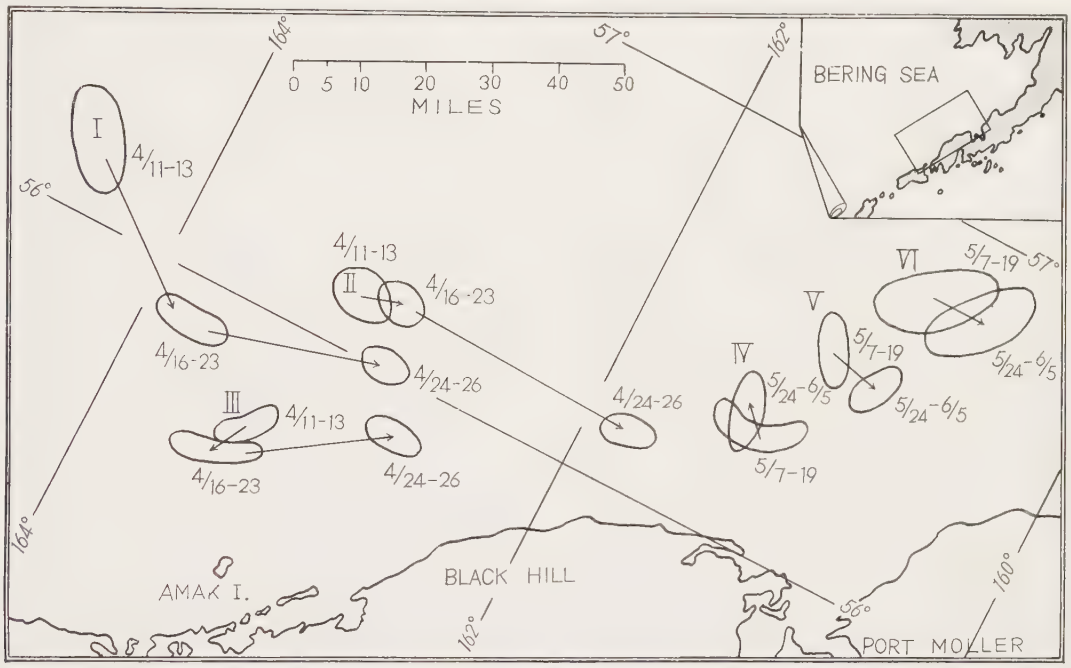

Figure 28. Distribution and migration of male crab populations. Data are based on scouting net catches.

B. Biological Investigations

1. Moulting and Spawning of Adult Females.

Most of the adult females carry out moulting, mating and ovulation within a very short period of time (in the above sequence) and at approximately the same time each year. The timing of reproductive activities can be determined from observed changes in the condition of eggs carried by females. Thus, moulting, mating and ovulation take place between a stage in which females have residual egg membranes (after the larvae have hatched out) on the abdominal appendages and a stage in which they carry newly produced eggs. According to Figure 29, the second and third weeks of June were the peak of female moulting and spawning in 1961.

There are certain distinguishable characteristics in female crabs that are ready for moulting. Such changes in appearance as in the membranes of the joints of walking legs have been known. This year's investigations revealed that the decalcification and softening of each section of the chela (particularly the anterior side of the base of the meropodite) preceded moulting. These characteristics, however, are a matter of degree and subject to personal judge-

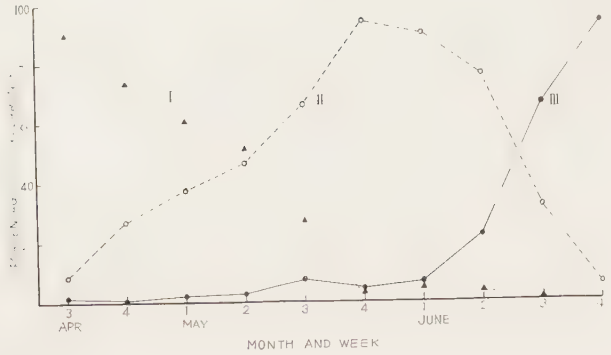

FIGURE 29. Occurrence of adult female crabs bearing (I) eggs with eye pigmentation, (II) empty egg shells, and (III) new eggs, brown or purple in colour.

ment, as in the case of the fouling of the ventral side of the basipodite of a walking leg; and they are not necessarily proper criteria for determining the stages of the moulting cycle. We, therefore, searched for more objective criteria and obtained the following findings:

(a) When the inside of dactylopodite of a walking leg is carefully pulled out by bending it at an intermediate point, a dactylopodite with a new nail (which is similar in shape to the old one) appears, if the specimen is a female ready to moult. If the specimen is not ready for moulting, only an unshaped piece of meat with nothing supporting it appears from the old shell.

(b) In specimens of more advanced stages, the membranous layer of the shell becomes gelatinized. As the process of gelanitization progresses, this layer is transformed into a mucous substance between the new and old shells, serving to reduce friction during the process of moulting. The loss of this layer is one factor contributing to the fragility of the old shell as the stage of moulting approaches.

(c) The swelling of the abdomen begins three to four days before actual moulting. When such swelling reaches its height, the membrane between the carapace and the first abdominal segment splits and the process of moulting starts.

Using these very apparent characteristics, the period of preparation for moulting (Drach's (1939) D-stage, also, Hiatt, 1948) may be divided into the following stages:

Stage D1: The new nails of dactylopodites of walking legs have begun to form.
Stage D2: The gelatinization of the membranous layer has begun.
Stage D3: The membranous layer has disappeared.
Stage D4: The swelling of the abdomen has begun. Moulting begins at the end of this stage.

It is, however, still somewhat doubtful whether our observations cover the entire period of preparation for moulting from its very beginning; and the above criteria are subject to modifications by results of future studies.

The process of fertilization was observed several times by using specimens kept in a wooden tank ($1 \times 2 \times 1$ m.). Sperm material is attached to a female prior to ovulation. It is always placed around the opening of the oviduct on the ventral side of the basipodite of the third walking leg. The material sticks to dense short bristles around the opening in a thick layer. The attachment of sperm material to other places is perhaps accidental or secondary.

During the process of mating, the genopores of the female and male contact each other. Sperm material is perhaps emitted at this moment, and attached to the female. Eggs being ovulated meet spermatozoa at the opening of the oviduct and are fertilized.

Sperm material is not carried to the female by the respiratory current caused by the vibratian of gill lamellae of the second maxillipeds. Also, the fifth walking legs of the male have no direct relation to the transfer of sperm material.

Observations were made on what happened if a female could not meet a mature male immediately after moulting. The following results were obtained from observations on the mothership:

(a) When a female was placed with a male prior to moulting or within twenty-four hours after moulting, mating and ovulation took place in the normal fashion, except in very few cases (two out of 16).

(b) In four cases in which a female was placed with a male within two to seven days after moulting, mating occurred immediately, but ovulation was incomplete, leaving a large amount of ripe eggs unspawned. Ovulated eggs, too, did not completely adhere to the abdominal appendages, and most of them dispersed in water.

(c) When a female was placed with a male nine days after moulting, neither mating nor ovulation took place.

(d) In all nine cases in which a female was kept separate from males after moulting, no ovulation took place.

TABLE 16. Process of post-moulting shell calcification in the various parts of the adult female body.

Period after moulting	Carapace			Chelae			Walking leg		
	Gastric area	Cardiac area	Branchial area	Palm region	Corpus	Merus	Dactyl	Spines and rostrum	Moulting stage
Immediately after moulting	S	S	S	S	S	S	S	S	A_1
2 hours	S	S	S	S	S	S	—	—	A_2
16 hours	—	—	—	S	S	S	—	—	A_2
3 days	±	—	—	—	—	—	±	±	A_2
7 days	±	±	±	—	—	—	±	±	B_1
9 days	±	±	±	—	±	—	+	+	B_1
12 days	+	±	±	±	±	—	+	+	B_1
15 days	+	+	+	±	±	±	+	+	B_2
20 days	+	+	+	±	±	±	+	+	B_2
28 days	++	+	+	±	±	±	+	++	B_2

S = Completely soft.
± = Partially rigid but easily depressed.
++ = Completely rigid.
— = Firm but easily depressed with slightest touch.
+ = Rigid but thin, and easily broken.

The process of shell calcification after moulting was observed for females kept in a tank on the mothership, with results as shown in Table 16. Unfortunately, observations continued for only 28 days after moulting, because of some technical problems regarding rearing facilities. Only the antero-gastric and the antero-branchial regions became completely calcified during the above period, the calcification of other parts remaining more or less incomplete. Particularly, the calcification of the base of the meropodite of the chela was very slow. The membranous layer was formed at stage B_1, according to the classification used in Table 16.

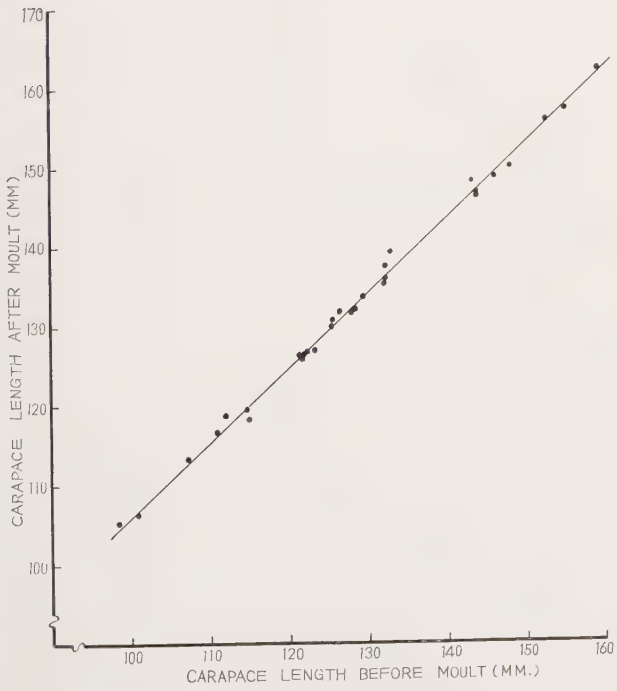

FIGURE 30. Growth diagram for the carapace length of adult female crabs.

Data on the growth increment per moult were obtained for 30 moulting females. In Figure 30, the carapace length after moulting (L_n+1) is plotted against that before moulting (L_n). Obviously, the relationship between the two quantities can be expressed by a straight line. The equation for the straight line is: $L_n+1=13.47+0.93\ L_n$.

The theoretical maximum carapace length (L_{00}) is: $L_{00}=13.47/(1-9.3)=192.4$ mm.

Hence, $L_{95}=L_{00}\times 95/100=182.4$ mm.

L_{95} is considered the practical maximum carapace length. This calculated value is fairly close to the maximum carapace length for females observed in the Bering Sea (170 mm., Wallace *et al.*, 1949).

2. Moulting and Growth of Juvenile Crabs.

A total of 371 juvenile crabs was collected during the crab fishing operation in the Port Moller area. The carapace lengths ranged from 8.5 to 30.2 mm. Most of these juveniles were kept alive on the mothership by feeding them with specimens of Caprellidae and pieces of crab meat. In 1960, rearing was carried out by keeping juveniles in small containers with intermittent running water; but in 1961 five relatively large tanks (approximately $30\times10\times20$ cm.) were used with abundant running sea water. As a result of this improvement, a total of 121 juveniles out of

the above number moulted normally and many data were added to the previous information on the growth of juvenile crabs.

The process of moulting of juvenile crabs is essentially the same as that of adults. The swelling of the abdomen, however, is far more marked than in adults. Such swelling started approximately six hours before the commencement of moulting for a specimen of 16 mm. with a water temperature of 7°C. The length of time from the puncture of the membrane between the carapace and the first abdominal segment to the completion of moulting was mostly three to six minutes, so far as our observations indicated. In no cases was it longer than 10 minutes.

Data on the growth increment per moult for juvenile crabs are given in Figure 31. All specimens in which a walking leg was missing or in regeneration were removed from the data. It is obvious that the growth of juveniles, too, can be expressed by a straight line. The equation for this line is: $L_n+1=-0.35+1.22\ L_n$.

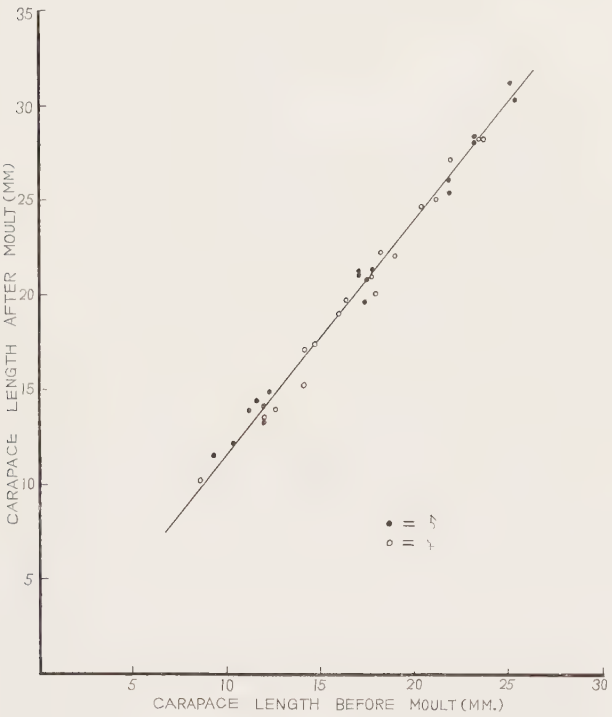

Figure 31. Growth diagram for the carapace length of juvenile crabs.

The constant for L_n is significantly greater than that for adult females. It probably indicates that the gradient of the line in the growth graph changes as crabs reach sexual maturity.

3. Loss and Regeneration of Walking Legs of Juvenile Crabs.

The loss and regeneration of walking legs (including chelae) were recorded at the time of collection, for all juvenile crabs collected. It was revealed that such loss and regeneration occurred in unexpectedly high proportions.

The loss of walking legs may be classified in three types: (1) losses at the point of autotomy (at the preformed breakage plane); (2) losses at points distal to that of autotomy; (3) losses at points proximal to that of autotomy. This method of classification has a biological significance, and the mechanism of regeneration differs between these three.

Table 17. Occurrence of limb injuries in juvenile crabs.

(a) *Injuries at the preformed breakage plane.*

Injuries	Frequency	
	No. of crabs	Percent (%)
Normal	160	43.1
1 leg, missing	50	13.5
1 leg, regenerating	68	18.3
2 legs, missing	13	3.5
2 legs, regenerating	39	10.5
3 legs, missing	4	1.1
3 legs, regenerating	9	2.4
4 legs, missing	1	0.3
4 legs, regenerating	5	1.3
5 legs, missing	1	0.3
1 leg missing, 1 leg regenerating	11	3.0
1 leg missing, 2 legs regenerating	3	0.8
1 leg missing, 3 legs regenerating	2	0.5
2 legs missing, 1 leg regenerating	1	0.3
2 legs missing, 2 legs regenerating	2	0.5
2 legs missing, 3 legs regenerating	1	0.3
3 legs missing, 1 leg regenerating	1	0.3
Total	371	

(b) *Injuries distal to the preformed breakage plane (including both missing and regenerating).*

Division of classification in (a)	Missing or regenerating distal part from				
	Normal	Corpus	Propus	Dactyl	Total
Normal	145	2	11	2	15 (9.4%)
Any legs missing or regenerating	174	3	12	7	22 (10.4%)
Total	319	5	23	9	37 (10.0%)

As far as the specimens collected in 1961 are concerned, there is no instance of loss at a point distal to that of autotomy.

Using only losses of walking legs at the point of autotomy and regenerations therefrom, all samples were classified as in Table 17 (a). Only 43.1 percent of individual crabs had no missing or regenerating legs. The remainder, 56.9 percent, had one to five legs that were missing or regenerating. These normal crabs and crabs with missing (or regenerating) legs were further classified according to the presence or absence of loss or regeneration at a point distal to that of autotomy, resulting in Table 17 (b). Thus, approximately 10 percent each of the normal crabs and crabs with missing or regenerating legs, according to the criteria in Table 17 (a), showed additional losses or regenerations of legs at a point distal to that of autotomy. It is noted that there were no traces of losses at a point proximal to the meropodite. This is perhaps because any injury between the tip of the meropodite and the point of autotomy invariably causes a breakage at the latter point.

Missing legs are regenerated sooner or later, but the rate of such regeneration presumably has great bearing on the survival of juvenile crabs. For this reason, the rate of regeneration was determined by using crabs with lost legs (by autotomy) that moulted in a tank. Measurements of carapace length and the meropodite length of the regenerating leg were made. For chelae, however, the propodite was measured instead of the meropodite. The condition of regeneration was expressed by the rate of regeneration R (where $R = l/L \times 100$). l is the meropodite (or propodite) length of a regenerating leg, and L is the length of the same portion which would be attained if the leg had not been injured. The latter length was determined by using a relative growth formula between carapace length and the meropodite (or propodite) length of each walking leg obtained from normal individuals.

When the rate of regeneration after moulting is plotted against that before moulting, a straight line is obtained for each leg, as shown in Figure 32. Based on these relationships, the process of regeneration after autotomy can be calculated, and the regeneration curves as shown in Figure 33 are obtained. According to this figure, regeneration reaches 80 percent of the normal length in four moultings after

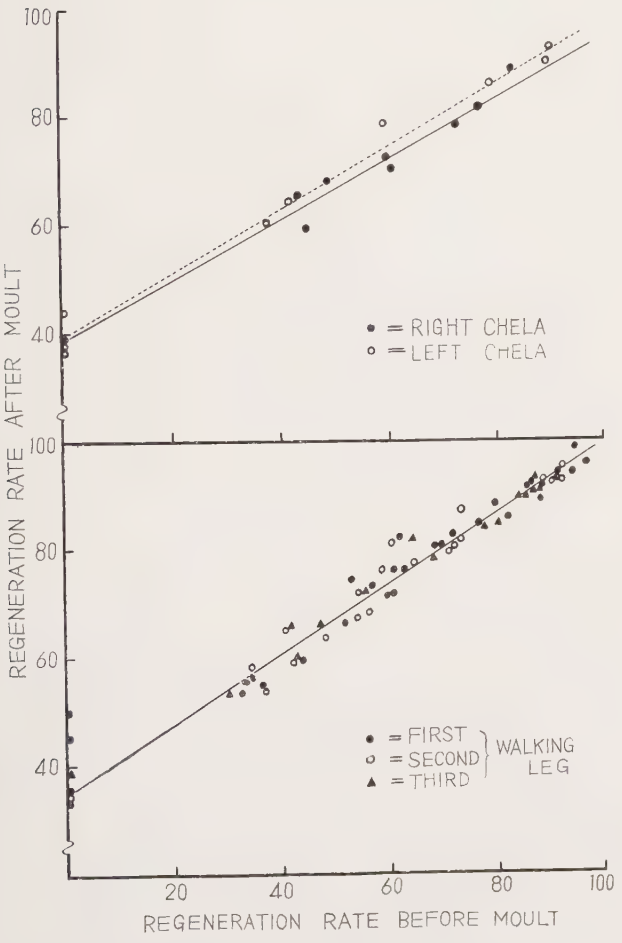

Figure 32. Regression of regeneration rate after moult against that before moult in juvenile crabs.

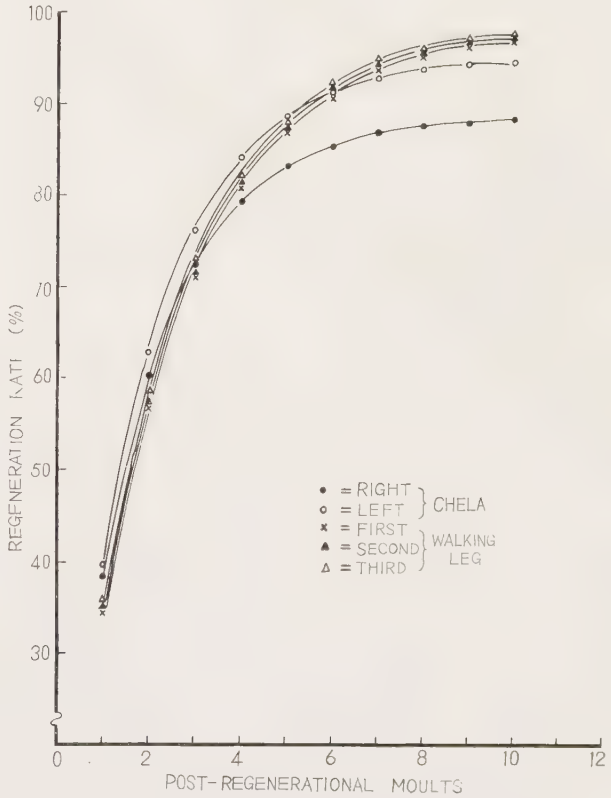

Figure 33. Regeneration curves for juvenile crabs.

autotomy. The figure indicates that the regeneration of chelae (particularly the right chela) is retarded thereafter; however, it is not certain whether this reflects the normal process of regeneration, because basic data on chelae regeneration (see Figure 32) are not sufficient. For other legs, about 95 percent of the normal length is recovered in seven or eight moultings after autotomy.

4. Recaptures of Tagged Crabs.

A total of 443 tagged crabs was recaptured by the *Tokei-maru* fleet during the spring season of 1961 (Table 18). Except in a very few cases, the tag number was recorded, carapace length and carapace width measured, and the condition of shell observed for every recapture. Tags recovered from United States tagging have been forwarded to the United States with complete recapture records. There are certain tags for which the source is unknown and inquiries are being made for these.

Table 18. Recovery of tags by *Tokei-maru*, 1961 spring season.

Tagged by	Tagging year	Numbers recovered		
		Males	Females	Total
U.S.A.	1955	2	—	2
"	1956	37	—	37
"	1957	141	—	141
"	1958	79	39	118
"	1959	77	—	77
"	1960	24	—	24
Total (U.S.A.)		360	39	399
Japan	1959	4	—	4
"	1960	16	—	16
Total (Japan)		20	—	20
Others		24	—	24
Grand Total		404	39	443

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C. REPORT ON THE INVESTIGATIONS BY THE UNITED STATES FOR THE INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION—1961

Bureau of Commercial Fisheries, April, 1962

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INTRODUCTION

As a part of the Commission's research into problems defined in the Protocol to the Convention, the United States has undertaken to study certain aspects of the salmon in the high seas. The studies have been planned jointly with those pursued by Canada and Japan, and the cooperative effort was designed to provide an integrated approach to the solution of the more critical questions. The United States has studied the origin, movements, distribution and abundance of salmon in the North Pacific Ocean and Bering Sea as well as some of the environmental factors influencing their distribution and abundance. Studies of the king crab of the eastern Bering Sea and its fishery have been conducted on a cooperative basis with Japan.

The purpose of the following reports is to provide information regarding the studies in progress and their status at the end of 1961. For convenience the reports are presented according to the units in which the work was done. The investigation of distribution, abundance, and migration of salmon are reported under Tagging Studies and Salmon Distribution and Abundance on the High Seas. Study of the factors controlling these are reported under Oceanography. Progress in determining the origin of salmon on the high seas is reported under Salmon Serology, Morphological Classification of 1960 Red Salmon, Red Salmon Scale Studies, Pink Salmon Studies, and Chum Salmon Studies.

The tagging work was performed by the Fisheries Research Institute of the University of Washington. The remainder was done by the Seattle Biological Laboratory of the United States Bureau of Commercial Fisheries.

TAGGING STUDIES

by A. C. Hartt

High seas salmon tagging research by the United States in 1961 consisted of two major projects, a two-vessel operation in the Aleutian area similar to that of previous years, plus a new two-vessel operation in the Gulf of Alaska. Work in both areas was done by the Fisheries Research Institute of the University of Washington under contract with the U. S. Fish and Wildlife Service, Bureau of Commercial Fisheries. For convenience, operations in the two areas will be reported separately.

Aleutian Area Tagging

The purse seine vessels *Commander*, 81 feet, and *Renown*, 85 feet, were chartered for the 1961 Aleutian salmon tagging operations. Both vessels departed Seattle April 27. The *Commander* returned September 3, and the *Renown*, September 9.

Purse seines were similar to those described for 1960. The water inflow in fish holding tanks was altered to reduce turbulence.

Three types of tags were used. Red and white disc tags $\frac{3}{4}$-inch in diameter were used on most mature fish and on the larger immatures. White discs $\frac{1}{2}$-inch in diameter and white tubes $\frac{1}{16}$-inch in diameter were used on the smaller immatures.

The anesthetic MS 222 was used on some samples in order that tagged fish could be weighed.

Principal objectives in 1961 were fourfold:

1. To tag all species of salmon along the Aleutians to compare distribution of Asian and American salmon with that of previous years.

2. To make particular effort to tag mature red salmon in western Aleutian areas (Kiska-Attu) early in the season.

3. To find routes, timing, and relative abundance of major flows of mature red salmon approaching Bristol Bay during June.

4. To obtain an index of abundance of immature red salmon in the central and western Aleutians in July and August.

Table 1 presents the totals tagged by area and by species. Figure 1 illustrates the areas referred to in the table.

Objective 1 was carried out satisfactorily as far

Table 1. Numbers of salmon tagged in Aleutian areas—1961.

Area[1]	Inclusive dates	No. of seine sets	Numbers tagged by species						
			Red	Chum	Pink	Silver	King	Steelhead	Total
E7550	8/ 7–8/16	7	431	94	2	12	8	—	547
8052	6/23–7/9	4	5	66	8	—	—	—	79
8050	6/ 6–8/23	52	1390	2043	1275	11	20	—	4739
W7550	7/ 7–7/20	4	5	116	8	1	1	—	131
W7054	6/23	4	77	24	5	—	5	—	111
W7052	5/14–7/27	37	3144	1617	892	5	34	—	5692
W6556	6/24–6/26	4	362	17	—	—	3	—	382
W6554	5/11	2	—	1	—	1	—	—	2
Total		114	5414	3978	2190	30	71	—	11683

[1] See Figure 1.

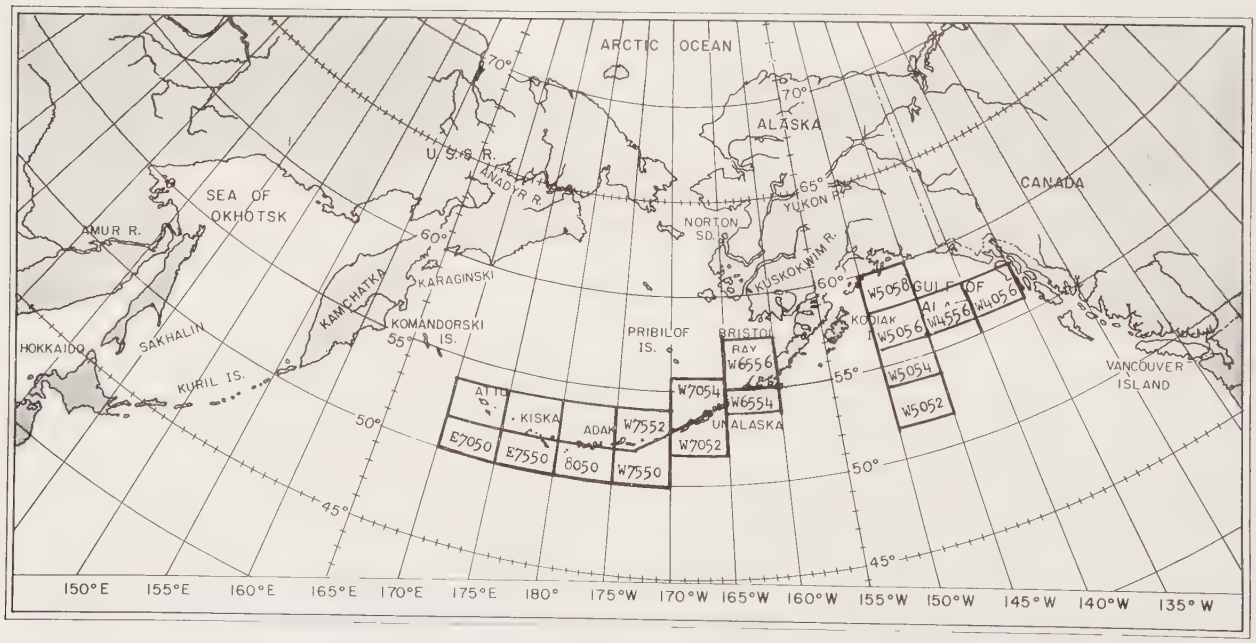

Figure 1. Reference map with key to area code.

west as 175°E. longitude. Large numbers of mature reds, chums, and pinks were tagged from early June in central and eastern Aleutians. Immature reds and chums were tagged between Umnak and Kiska from late June to mid-August. Pinks were plentiful during June and were moving strongly westward.

We failed to achieve objective 2 because of bad weather during mid- and late May.

Objective 3 was fulfilled satisfactorily. Seine catches showed large numbers of mature reds passing westward on the south side of both eastern and central Aleutians indicating a major flow of reds approaching Bristol Bay via Amukta Pass (172°W.) and Amchitka Pass (180°) (see Fig. 2). Presumably, reds also approached from further west as observed in previous years, but as mentioned earlier, weather prevented seining in western areas early this year. Results of Japanese tagging early in the season and far to the west, however, confirm that important numbers of reds approached Bristol Bay from as far west as 165° E. longitude. The average seine catch of mature red salmon south of Adak was 82 compared with 75 in 1960, while south of Umnak it was 214 this year compared with 125 in 1960 for comparable dates.

Objective 4 was fulfilled satisfactorily. It was noteworthy that the center of abundance of immature reds passing westward south of Adak in 1961 was apparently about 25 to 35 miles offshore. Catches at this distance offshore averaged 58 reds as against eight reds in the usual inshore index area. South of Adak reds were over 85 percent 1-winter immatures, while further west, south of Kiska, they were only about 50 percent 1-winter age. It is hoped that sufficient returns will be received in 1962 to show whether these two groups have different origins.

Tag recovery efforts in 1961 were similar to those of 1960 except that the $25 reward for fish with tags attached was discontinued. The usual $1 reward was offered, with emphasis on the return of fish with tag attached. A special award of $300 was also made by the Alaska Fishermen's Union for one tag drawn from all tags received through September 15. This undoubtedly bolstered tag returns. Tag recovery effort for the several coastal tagging experiments by the U. S. Fish and Wildlife Service and the Alaska Department of Fish and Game also helped the high seas tag return this year. Tag recovery at Igiugig on the Kvichak River using small explosive charges was undertaken again in 1961 and resulted in the capture of 35 fish bearing tags from high seas experiments.

Prior to discussing tag returns, it should be pointed out that at time of writing, returns are nearly complete from United States and Canadian coastal areas, and from the Japanese high seas fleet. However, based on previous years' experience, additional chum returns may be forthcoming from Japan, and additional chum and pink returns should be received from the U.S.S.R.

Figures 2 and 3 show 1961 red salmon returns to date. The 573 mature reds tagged south of Adak (Fig. 2) yielded 40 returns from Bristol Bay, plus 27 from the high seas. The high seas returns again illustrate the migration path toward Bristol Bay as shown in previous years. The lack of returns from the heavy high seas fishery to the west and the lack of Asian coastal returns emphasize that the large run of reds passing this area must have been almost

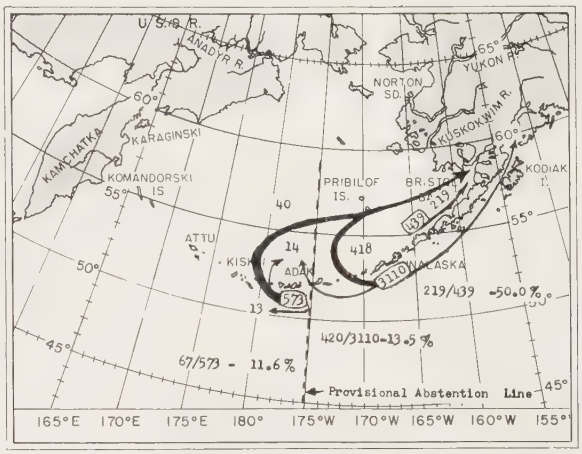

FIGURE 2. Recovery distribution of reds tagged in 1961—recovered in 1961.

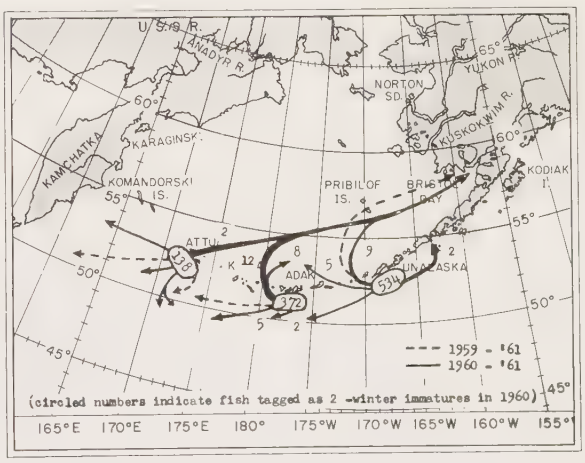

FIGURE 3. Recovery distribution of reds tagged in 1959 and 1960—recovered in 1961.

wholly Bristol Bay fish. The 13 returns from south of Adak is a departure from previous years and may indicate expansion of the Japanese fleet into this area where Bristol Bay reds have been shown to concentrate each year. The 14 from north of Adak indicate a heavy take of Bristol Bay reds here as in 1956, 1957, and 1960. The 11.6 percent overall return compares with a 13.6 percent return from releases in this area in 1960.

The 3,110 reds tagged south of Umnak yielded 418 returns from Bristol Bay, one from Cook Inlet, and one from the high seas north of Adak. This overall return rate might have been larger if not for the fact that some of the seine catches in this area were very large and fish were held a long time in the tanks, or in the bunt of the seine, which undoubtedly reduced survival. Some smaller samples yielded 30 percent returns, comparable with the results in 1960. The distribution of returns indicates that the reds passing this area were also almost wholly destined for Bristol Bay, and that few of this group traveled west of the provisional abstention line (175°W.) before entering the Bering Sea.

The 439 tagged in the Bering Sea between 161° and 166° W. longitude yielded 219 returns, all from Bristol Bay. The 50 percent overall return rate compares with approximately 35 percent in 1960, but most tagging in 1961 was much closer to the fishery than in 1960.

Opposed seine sets again showed the great predominance of the westward movement south of the Aleutians. On June 17, south of Umnak, for example, three consecutive sets yielded the following:

Set #1—open East—170 salmon
Set #2—open West—0 salmon
Set #3—open East—448 salmon.

Returns in 1961 of 54 reds tagged as immatures in 1959 and 1960 are illustrated in Figure 3. The arrows are drawn for convenience and are not intended to indicate migration routes during the year at liberty.

The usual pattern of predominance of Bristol Bay fish in all areas of tagging is evident.

The high seas returns reflect the areas of concentration of Bristol Bay reds north and south of Adak as described for mature fish sampled in these areas. The returns from south of Attu and Kiska were very likely Bristol Bay reds judging by date and location of recapture since all were recaptured prior to June 6. The three recaptured west of 170°E., however, were most probably Kamchatkan reds since they were recaptured between June 22 and July 6. It is perhaps meaningful that all three had been released in the Attu area.

It is also important that seven of the 18 returns from immature reds tagged in 1960 in the eastern Aleutians, south of Umnak Island, were from the high seas fishery north and south of Adak in 1961. Thus, unlike mature reds tagged in this area, immatures travel well west of the provisional abstention line during their year of liberty, and are exposed to high seas fishing.

The two recovered at Cape Lutke (south side Unimak Island) might furnish a clue to the migration route of reds between summer of one year and spring of the following year. Since immature reds move strongly westward along the south side of the Aleutians from late June through August, and since mature reds again move westward in the eastern Aleutians the following June, there is the question of whether part of the fish move eastward again during the winter. The location of these two returns suggests that they had moved eastward to repeat the westward movement as matures. Previous years' tagging has shown that many reds were found well to the west early the following spring and probably did not return east during the winter. As mentioned earlier, Japanese tagging in 1961 showed Bristol Bay reds in abundance as far west as 165° E.

The return by age group from 1960 is also of considerable interest. As shown in Table 2, the overall rate of return after a year at liberty was 0.2 percent for 1-winter fish and 4.6 percent for 2-winter fish.

Table 2. Percent return by age group and area of release of immature reds tagged in 1960 and recovered in 1961.

Area of release	Number released in 1960 as 1-winter	Number returned in 1961 as 2-winter	Percent returned	Number released in 1960 as 2-winter	Number returned in 1961 as 3-winter	Percent returned
Attu	71	0	0	138	6	4.3
Adak	163	0	0	372	26	7.0
Umnak	909	2	0.2	534	16	3.0
Total	1,143	2	0.2	1,044	48	4.6

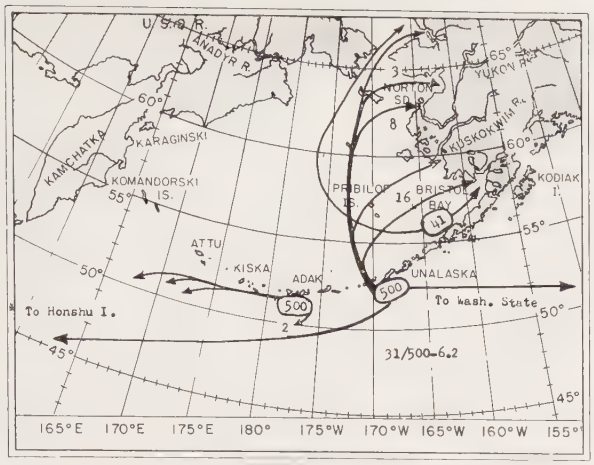

FIGURE 4. Recovery distribution of chums tagged in 1961—recovered in 1961.

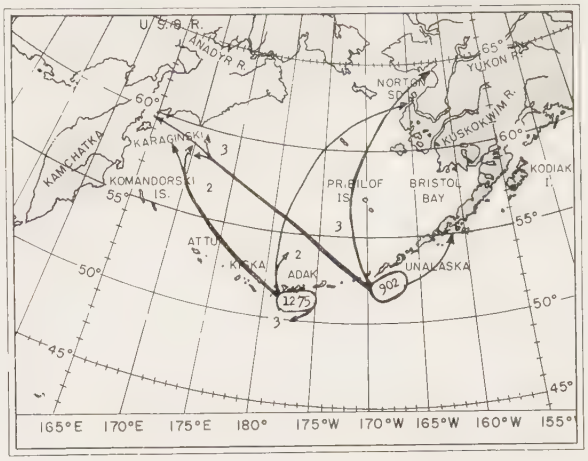

FIGURE 5. Recovery distribution of pinks tagged in 1961—recovered in 1961.

Additional returns from the 1-winter group may be received in 1962.

Figure 4 illustrates chum salmon returns to date. Numbers of matures tagged are preliminary estimates.

Of 31 returns from about 500 releases south of Umnak Island, one was from Honshu, one was from the State of Washington, and the remainder from the northwest coast of Alaska. The one from Washington was of particular interest since it was taken on rod and reel in the Hama Hama River on December 21, 1961. The 500 matures tagged south of Adak yielded only seven high seas returns. It is likely that there will be U.S.S.R. coastal returns and possibly additional Japanese coastal returns from 1961 chum releases.

In addition, the following chums were returned in 1961 from releases of immatures: one from 1957, two from 1958, three from 1959, and 10 from 1960. All were from the Japanese high seas fishery, and recovery points were far west of release points.

Figure 5 illustrates pink salmon returns to date. The outstanding feature is the return in an odd year of pinks from both continents. In 1957 and 1959, large numbers were tagged, yet returns came only from East Kamchatka or intermediate high seas points. In view of the small number of high seas returns, there should be additional returns from the U.S.S.R. The one return from the south side of the Alaska Peninsula is the first evidence of pinks moving eastward from Aleutian tagging. However, it should be pointed out that this specimen was not from among the main body of pinks which passes westward in June. It was taken on July 21 when pinks were relatively scarce. Further, opposed sets of the seine showed pinks to be moving predominantly eastward at this time and location. This suggests that some pinks destined for the Alaska Peninsula pass eastward through these waters following the westward passage of East Kamchatkan and northwest Alaskan pinks.

No cohos, and but one chinook salmon have been returned to date. The chinook was tagged north of Unimak Island and recovered at Egegik in Bristol Bay.

Gulf of Alaska Tagging

Vessels chartered for the Gulf of Alaska tagging were the purse seiners *Ocean Pride*, 87 feet, and the *Storm*, 81 feet. The *Ocean Pride* departed Seattle May 22, and returned August 31. The *Storm* departed May 16, and returned October 5.

Seine gear, methods, and types of tags of Gulf vessels were similar to those previously described for the Aleutian operations. Because the Gulf tagging contract was not received until mid-April, there were problems in getting seine materials in time for departure of the Gulf boats in mid-May. The *Storm* was able to depart May 16 by using the seine normally carried as a spare for Aleutian operations. The upper two strips of the *Storm* seine were of very fine ($1\frac{1}{2}$-inch) herring web because $2\frac{1}{2}$-inch web was not readily available. The *Ocean Pride* seine was new, entirely of synthetic knotless material, and proved very efficient.

Objectives of the Gulf operation were:

1. To learn the ocean distribution, timing, and

movements of major stocks of salmon originating in streams tributary to the Gulf of Alaska.

2. To learn the eastern limits and relative abundance of Bristol Bay red salmon and northwest Alaskan chums and possibly pinks in the Gulf of Alaska.

The *Ocean Pride* was assigned seven stations in the eastern half of the Gulf and the *Storm* seven stations in the western half, north of 54°N. Stations included both inshore and offshore areas. In addition, the *Commander* and *Renown* made several sets in the Gulf as they were en route to and from the Aleutians.

Table 3. Numbers of salmon tagged in Gulf areas—1961.

Area[1]	Inclusive dates	No. of sets	Number tagged by species						
			Red	Chum	Pink	Silver	King	Steelhead	Total
W6054	8–30 —	3	2	6	0	0	5	0	13
W5558	6–14 9–13	11	36	30	8	1	23	0	98
W5556	6– 2 9– 8	28	189	70	31	3	179	0	472
W5554	6–22 —	2	—	—	—	—	—	—	—
W5552	7–28 —	3	33	26	1	2	0	0	62
W5060	9–16 9–20	6	9	54	54	0	60	0	177
W5058	5– 4 9–15	38	40	472	133	3	207	0	855
W5056	6– 3 8– 7	16	50	193	64	15	5	8	335
W5054	6–23 7–26	10	53	96	42	5	3	1	200
W4558	6– 4 9–21	23	68	290	378	63	286	0	1,085
W4556	5–23 8– 4	16	20	59	148	2	1	1	231
W4554	6–18 8– 3	15	8	85	119	0	4	2	218
W4552	8– 2 —	4	1	12	0	0	1	0	14
W4058	5– 3 9–22	21	34	103	394	12	327	0	870
W4056	5–28 9–26	31	51	257	545	21	172	3	1,049
W3050	9–29 —	3	0	10	7	0	1	0	18
W3048	8–28 —	2	0	0	2	0	6	0	8
W2548	8–30 —	1	1	0	12	60	260	0	333
Grand Total		233	595	1,763	1,938	187	1,540	15	6,038

[1] See Figure 1.

Table 3 lists numbers of salmon tagged by the area and species. Figure 1 illustrates the code system for areas of tagging (2° Lat. × 5° Long.).

As may be seen from Table 3, the average number of salmon tagged per set was approximately 26. In general, larger catches were made at stations closer

Table 4. Recoveries of red salmon tagged in the Gulf of Alaska in 1961 (tags received through January 1, 1962).

Recovery area	Area of release (see Fig. 1)							
	W5556	W5058	W4558	W4556	W4058	W4056	W2548	Total
Bristol Bay	1							1
South side Alaska Peninsula	2							2
Kodiak Island	2							2
Cook Inlet	1		1					2
Cook Inlet to Prince William Sound								0
Prince William Sound								0
Copper River	1	1		1	2			5
Copper River to Cape Spencer			3		1			4
S.E. Alaska north of 56°			1		9	1		11
S.E. Alaska south of 56°						1		1
Skeena River						4		4
Queen Charlotte Sd.						2		2
West Coast Vancouver I.							1	1
Johnstone Strait								0
Total	7	1	5	1	12	8	1	35

to the coast, probably because of the "leading" effect of the coastline. The direction of movement of salmon at the time of catch was often mixed, but in some areas rather definite patterns were evident. The catch data when broken down by specific location, by direction of movement, by species, and by maturity, should contribute considerable new knowledge of salmon movements in the Gulf.

Returns from the Gulf experiments received through January 1, 1962, are summarized in Tables 4 through 8. Figures 6, 7, and 8 show the general recovery patterns for red, chum, and pink salmon respectively. Every return could not be conveniently illustrated because of the large number of release points and the mixed pattern of movement.

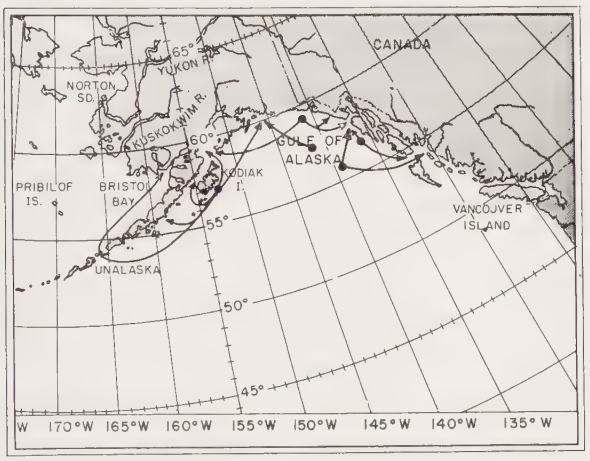

FIGURE 6. Diagram of general recovery pattern of red salmon tagged in the Gulf of Alaska in 1961. (All returns not shown because of space limitation—see Table 4.)

Purse seine catches were markedly smaller in the Gulf of Alaska than in the Aleutian Islands area. In general, tag returns indicate that fish tagged at any one station are destined for a variety of spawning grounds. Even at inshore stations, fish often moved north, south, east, and west from a single tagging point. However, data to date do suggest some general trends in some cases. Further analysis by date of release and by size of runs to recovery areas is needed.

Red salmon were found in limited numbers in most areas of fishing. The 35 returns (Table 4 and Fig. 6) are from approximately 225 mature reds tagged, or 15.6 percent. Table 4 and Figure 6 indicate considerable mixing of reds destined for various spawning areas. Because bad weather limited fishing, insufficient numbers of reds were tagged early in the season in the western areas to show the full distribution of reds passing through these waters. In 1958, for example, 26 reds tagged south of Kodiak Island yielded five returns from the approaches to the Fraser River, and in 1959, six reds tagged in the same area yielded one return from the Fraser and one from Bristol Bay. Since the western Gulf is apparently an important feeding area for immature red salmon, early tagging here on a large scale should result in more widespread returns than that shown in Table 4. Immature reds were tagged in small numbers over wide areas in 1961 and should yield valuable return data in 1962. The lack of appreciable catches of immature reds suggests that our vessels did not encounter the main bodies of immature Fraser River fish.

TABLE 5. Recoveries of chum salmon tagged in the Gulf of Alaska in 1961 (tags received through January 1, 1962).

	Area of release (see Fig. 1)								
Recovery area	W5558	W5556	W5058	W5054	W4558	W4556	W4058	W4056	TOTAL
Bristol Bay									0
South side Alaska Peninsula	1	3	1						5
Kodiak Island		2	1						3
Cook Inlet									0
Cook Inlet to Prince William Sound			1						1
Prince William Sound	2		4						6
Copper River									0
Copper River to Cape Spencer									0
S.E. Alaska north of 56°			3	1	28	1	13	2	48
S.E. Alaska south of 56°			1	1				1	3
Skeena River									0
Queen Charlotte Sd.								1	1
West Coast Vancouver I.									0
Johnstone Strait									0
TOTAL	3	5	11	2	28	1	13	4	67

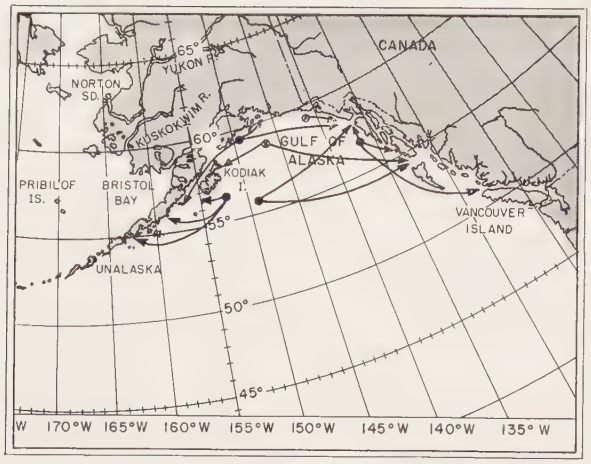

FIGURE 7. Diagram of general recovery pattern of chum salmon tagged in the Gulf of Alaska in 1961. (All returns not shown because of space limitation—see Table 5.)

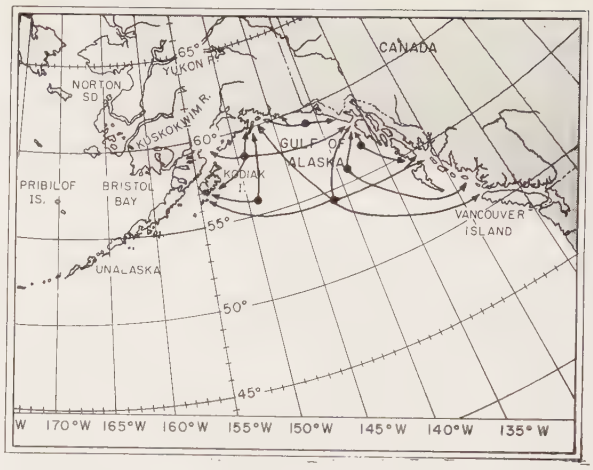

FIGURE 8. Diagram of general recovery pattern of pink salmon tagged in the Gulf of Alaska in 1961. (All returns not shown because of space limitation—see Table 6.)

TABLE 6. Recoveries of pink salmon tagged in the Gulf o Alaska in 1961 (tags received through January 1, 1962).

Recovery area	Area of release (see Fig. 1)										Total
	W5558	W5556	W5058	W5056	W5054	W4558	W4556	W4554	W4058	W4056	
Bristol Bay											0
South side Alaska Peninsula											0
Kodiak Island	7		2	7			1				17
Cook Inlet		1									1
Cook Inlet to Prince William Sound											0
Prince William Sound		14	3	2	6	3	3	2			33
Copper River											0
Copper River to Cape Spencer		1			6						7
S.E. Alaska north of 56°		5		1	52	6	1	45	29		139
S.E. Alaska south of 56°						1	2		7		10
Skeena River						1	2		8		11
Queen Charlotte Sd.						1	1	1	9		12
West Coast Vancouver I.											0
Johnstone Strait						1	1				2
Total	7	21	5	10	64	13	11	48	53		232

Chum salmon returns are listed in Table 5 and illustrated diagrammatically in Figure 7. The percent return based on a preliminary estimate of number of matures is 9.3 percent (67 out of 720 matures tagged). In general, an eastward movement seems to prevail, suggesting that main feeding areas are in the western part of the Gulf. This is in keeping with the fact that the vessel operating in the western part of the Gulf caught many more immature chums than did the vessel in the eastern half. Returns in 1962, of salmon tagged as immatures, should add considerably to the migration pattern.

Pink salmon yielded an overall return of 232 out of 1,542 matures tagged, or 15.0 percent. As shown in Table 6 and Figure 8, returns from most release points were from widespread locations. This suggests that pinks from all Gulf stocks are mixed widely at sea. Almost 400 immature pinks were tagged late in the season at several inshore stations, but the probability of recoveries in 1962 is slight because of the very small size of pinks at that stage of their life.

Tables 7 and 8 list returns of coho and king salmon respectively. Seventeen cohos were returned from 187 matures tagged, or 9.1 percent. Fourteen kings were returned from 1,540 released. These have not been classified by maturity. A large proportion of

TABLE 7. Recoveries of coho salmon tagged in the Gulf of Alaska in 1961 (tags received through January 1, 1962).

Recovery area	Area of release (see Fig. 1)						
	W5058	W5056	W5054	W4558	W4056	W2548	TOTAL
Copper River	1	1		1			3
Copper River to Cape Spencer			1	2			3
S.E. Alaska north of 56°					1		1
S.E. Alaska south of 56°				3			3
Washington Coast						1	1
Fraser River						3	3
Puget Sound						3	3
TOTAL	1	1	1	6	1	7	17

TABLE 8. Recoveries of king salmon tagged in the Gulf of Alaska in 1961 (tags received through January 1, 1962).

Recovery area	Area of release (see Fig. 1)			
	W4558	W4058	W2548	TOTAL
Copper River to Cape Spencer		1		1
S.E. Alaska north of 56°	2	3		5
West Coast of Vancouver I.			2	2
Strait of Juan de Fuca			5	5
Fraser River			1	1
TOTAL	2	4	8	14

kings tagged were small immature fish, but large enough that returns in 1962 and 1963 should be substantial.

A single steelhead was returned from the 15 tagged. It was released near Baranof Island off Southeast Alaska and recovered in Queen Charlotte Sound. Maturity of the steelhead tagged has not been determined.

Note: Since submission of the above report on U. S. high seas tagging for 1961, an additional 26 tags were received from the U.S.S.R. Table A summarizes these returns by species, year, and area. The one red salmon returned is of particular interest. It was tagged as a 2-winter age immature fish south of Adak on July 9, 1960, and recovered July 25, 1961, in the Kamchatka River estuary. This is the easternmost tagging to date that has yielded a red salmon return from the Asian coast.

TABLE A. Release and recovery data for 26 U.S. tags returned by the U.S.S.R. in March, 1962.

No. of recovered fish	Species	Year tagged	Year recovered	Area of tagging	Recovery location
1	Red	1960	1961	8050	Kamchatka River
1	Chum	1961	1961	8050	W. Kamchatka
1	Chum	1961	1961	8050	E. Kamchatka
4	Chum	1961	1961	8050	Sakhalin Island
2	Chum	1961	1961	W7052	E. Kamchatka
3	Chum	1961	1961	W7052	Anadyr River
1	Chum	1960	1961	8050	Okhotsk Coast
1	Chum	1960	1961	W7052	Okhotsk Coast
1	Chum	1959	1961	E 7052	Okhotsk Coast
1	Chum	1959	1961	E 7052	Sakhalin Island
6	Pink	1961	1961	8050	Karaginsky area
3	Pink	1961	1961	W7052	Karaginsky area
1	Pink	1961	1961	W7052	U.S.S.R. unknown

(In addition one pink salmon tagged by the U.S. Bureau of Commercial Fisheries south of Unimak Island was recovered on East Kamchatka).

SALMON DISTRIBUTION AND ABUNDANCE ON THE HIGH SEAS

by Robert French

This marks the seventh year that United States chartered research vessels have gillnetted salmon on the high seas to determine their distribution and abundance. The primary objectives of the fishing cruises in 1961 were to increase our information of salmon distribution and abundance and to collect whole fish and blood samples for racial studies. Specifically, efforts were made to collect samples from the area of the Japanese mothership salmon fishery in May and June and to gain information on the abundance of the current Bristol Bay red salmon run in the eastern Bering Sea during the month of June. Fishing was continued south of the Aleutian Islands during July and August to obtain an index of the abundance of immature red salmon. In addition, fishing cruises in the Gulf of Alaska increased our knowledge of salmon found in that area. The stations fished in 1961 are shown in Figure 9.

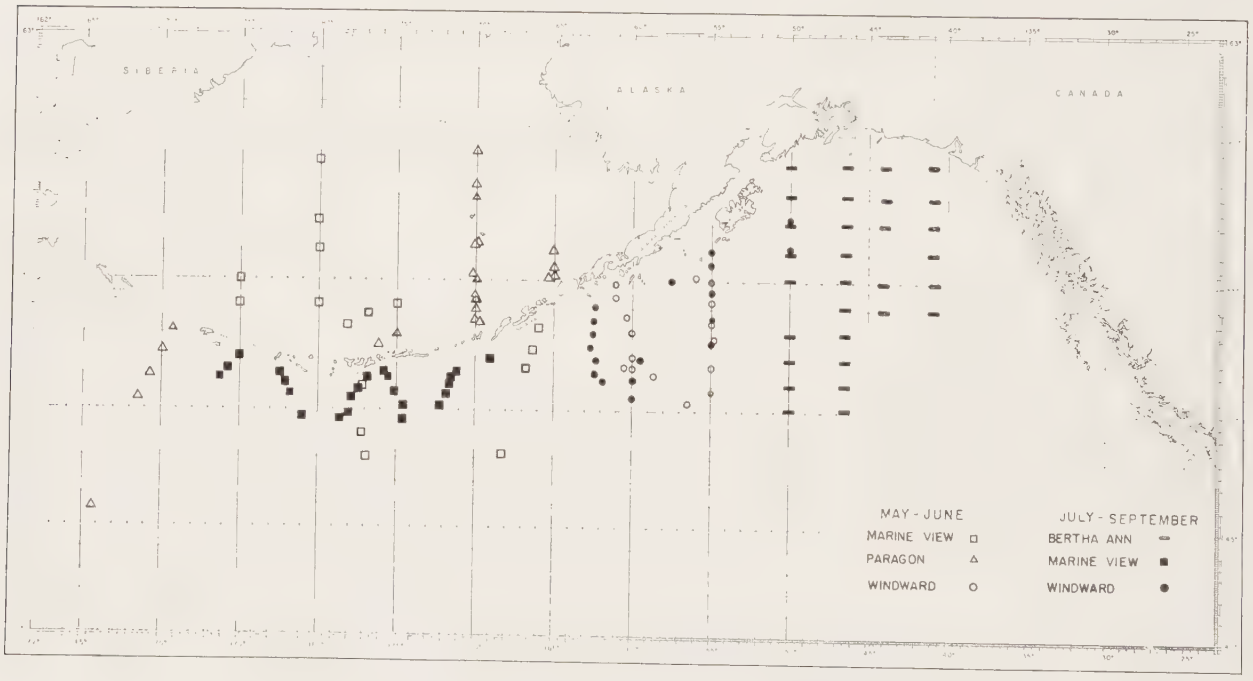

FIGURE 9. Fishing stations of United States research vessels in 1961.

Four gillnet fishing vessels were chartered for the 1961 season. These were the schooner *Paragon*, the seiners *Marine View* and *Windward*, and the *Bertha Ann*, a converted Army refrigerated cargo vessel.

The fishing effort per vessel in 1961 was similar to that of 1959 and 1960 with the exception that four additional shackles of net ($3\frac{7}{8}$-inch mesh) were added to the 36 shackles used the previous two years. The standard for all four vessels in 1961 was thus 40 shackles of net (2,000 fathoms) made up of 24 shackles of $4\frac{1}{2}$-inch mesh and four shackles each of $5\frac{1}{4}$, $3\frac{7}{8}$, $3\frac{1}{4}$, and $2\frac{1}{2}$-inch mesh. The $3\frac{7}{8}$-inch mesh was used in order to fish a more even distribution of mesh sizes thus filling the $1\frac{1}{4}$-inch gap between the $3\frac{1}{4}$ and $4\frac{1}{2}$-inch mesh.

CATCH DATA

The main feature of the 1961 fishing cruises was the reduced catches of red, chum, and pink salmon. Table 9 lists the catches of the four vessels by individual sets and mesh sizes. For ease of comparisons with other years, catches in the Aleutian area and in the Gulf of Alaska will be reported separately. As in past years we have designated May and June as the spring season and July-September as the summer season.

Aleutian Area. Red salmon catches in the Aleutian area were much smaller than the catches obtained in 1959 and 1960[1]. While the fishing effort (number of shackles fished) averaged about 90 percent of that for 1959–60, total catches in 1961 were only 52 and 42 percent respectively of those for the two previous years. This was mainly because fewer immature fish were present in 1961. In the area south of the Aleutian Islands catches of immature red salmon during the summer season averaged about 1.6 fish per shackle compared to an average of about five fish per shackle in 1959–60. The catch per shackle of juvenile red salmon which had spent one year at sea was 1.7 fish; the catch was about 1.5 fish per shackle for immature fish which had spent two years at sea. These are the two age groups which after two and three years at sea will provide the bulk of the Bristol Bay red salmon runs in 1962.

Total chum salmon catches in the Aleutian area were about one-third of those in 1959 and 1960. The fishing effort was approximately the same in all three years. The catch per unit of effort of the juvenile chums (2-year-old fish) was about 45 percent of that obtained in 1959 and 1960; for the older chum salmon (3, 4, 5, and 6-year-old fish) the catch per unit of effort was about 34 percent of that obtained the two previous years.

Pink salmon catches were much lower than expected. In recent years in high seas areas pink salmon catches in odd numbered years greatly surpassed catches in even numbered years. The catch in 1961 was comparable to that in 1960 and far below 1959 catches.

Among species of less importance in the Aleutian areas (silver and king salmon and steelhead trout) the catch of silver salmon showed a marked increase over catches in past years. The 662 silvers caught were far more than have been taken in any other year. Sixty-four percent of the silver salmon catch in 1961 was taken in two sets south of the Aleutian Islands during the summer season. These two sets were at 51°31′N. latitude, and 177°46′E. longitude on July 26 and at 51°12′N. latitude and 173°58′E. longitude on July 30.

The king salmon catch of 48 fish in 1961 was similar to the 54 taken in 1960, but was about one-half of the total caught in 1959.

[1] High seas catch data are given in the Annual Report of the International North Pacific Fisheries Commission for 1959 and for 1960.

Steelhead trout catches in the Aleutian Islands area were reduced from those of the two previous seasons. The total of 33 steelhead was a little over half the number caught in 1959 and in 1960.

Gulf of Alaska. Catch data for the Gulf of Alaska are shown in the catch tables for the *Windward* and *Bertha Ann.* (See Table 9.) Of the red salmon catch of 2,093 fish in the western Gulf made by the *Windward*, 970 reds or 46 percent of the total were taken in one set on June 8 at 53°40′N. latitude and 160°24′W. longitude. In size and age composition these red salmon were similar to the 1961 adult run to Bristol Bay.

As shown in the table, chum salmon predominated in the catches during the summer season in the central and western Gulf of Alaska.

Catch by mesh size. The greatest number of salmon were taken in the $4\frac{1}{2}$-inch mesh. This was to be expected since each string of gear is composed of 24 shackles of $4\frac{1}{2}$-inch mesh and four each of the other sizes. Ranking the catches of the five mesh sizes by season (species combined) according to the number of fish caught per shackle, we have the following array: $4\frac{1}{2}$, $5\frac{1}{4}$, $3\frac{7}{8}$, $3\frac{1}{4}$, and $2\frac{1}{2}$-inch mesh in the spring season, and $3\frac{7}{8}$, $4\frac{1}{2}$, $3\frac{1}{4}$, $5\frac{1}{4}$, and $2\frac{1}{2}$-inch mesh in the summer.

Distribution and Relative Abundance

The distribution and relative abundance of the 1961 high seas salmon catches as measured by gillnets are illustrated in Figures 10 to 18. Because age determinations by scale readings have not been completed, we have estimated the abundance of juvenile and older aged fish from the numbers taken in the different mesh sizes. The smaller mesh sizes ($2\frac{1}{2}$ and $3\frac{1}{4}$-inch) usually catch red salmon which have spent one winter at sea and 2-year-old chum salmon. The larger mesh sizes ($3\frac{7}{8}$, $4\frac{1}{2}$, and $5\frac{1}{4}$-inch) usually take only red salmon which have spent two, three, or four winters at sea; 3, 4, 5, and 6-year-old chum salmon; and mature pink salmon.

Figures 10 to 15 show the relative abundance of the older age groups in the catches for both the spring and summer seasons. Relatively few large catches of red salmon were made at the stations fished this year. As previously stated, the total catch was lower than those of 1959 and 1960. Our catches in the Gulf of Alaska did not indicate dense concentrations of red salmon in the station pattern fished this year.

TABLE 9. Salmon catch by United

MV *Bertha Ann* August 12–September 29, 1961.

Set no.	Date	Position		Surf. temp. °C.	Number of shackles	Red					
						Mesh size					
		Latitude	Longitude			5¼	4½	3⅞	3¼	2½	TOTAL
1	8/12	58°00′N.	150°00′W.	11.2	38	0	0	0	0	0	0
2	8/13	59°06′N.	149°52′W.	12.6	38	0	4	2	0	0	6
3	8/17	56°59′N.	150°07′W.	13.6	38	0	3	1	0	1	5
4	8/19	55°58′N.	150°01′W.	13.6	38	0	3	3	1	0	7
5	8/20	54°56′N.	150°00′W.	12.4	38	0	3	1	1	0	5
6	8/21	52°59′N.	150°02′W.	12.8	38	5	15	4	0	0	24
7	8/22	52°00′N.	150°00′W.	12.9	38	3	34	9	0	0	46
8	8/23	51°01′N.	149°56′W.	12.8	38	0	12	4	0	0	16
9	8/24	50°00′N.	150°02′W.	12.9	35	0	0	0	0	0	0
10	8/25	50°00′N.	147°00′W.	13.3	35	0	0	0	0	0	0
11	8/26	51°00′N.	147°00′W.	13.2	35	0	0	0	0	0	0
12	8/27	52°00′N.	147°00′W.	13.3	35	1	3	0	0	0	4
13	8/29	53°00′N.	147°00′W.	13.2	35	0	5	1	0	0	6
14	8/30	54°00′N.	147°00′W.	12.8	35	0	10	1	0	0	11
15	8/31	55°00′N.	147°00′W.	13.4	35	1	14	3	0	0	18
16	9/1	56°00′N.	147°00′W.	13.3	35	0	10	0	0	0	10
17	9/2	57°00′N.	147°00′W.	13.2	35	0	1	0	0	0	1
18	9/3	58°00′N.	147°00′W.	13.6	35	1	0	1	1	0	3
19	9/4	59°00′N.	147°00′W.	13.8	35	0	0	0	0	0	0
20	9/10	59°00′N.	144°00′W.	13.1	12	0	0	0	0	0	0
21	9/14	57°59′N.	144°04′W.	13.0	34	0	1	0	0	0	1
22	9/15	57°00′N.	144°00′W.	12.6	34	0	0	0	0	0	0
23	9/17	55°00′N.	144°00′W.	12.8	34	0	0	0	0	0	0
24	9/20	54°00′N.	144°00′W.	12.1	34	0	0	2	0	0	2
25	9/21	54°00′N.	141°0C′W.	12.8	38	0	1	0	0	0	1
26	9/22	55°00′N.	141°00′W.	12.4	40	0	0	0	0	0	0
27	9/23	56°00′N.	141°00′W.	12.6	40	0	2	0	0	0	2
28	9/26	57°00′N.	141°00′W.	12.2	39	1	0	0	0	0	1
29	9/27	58°00′N.	141°00′W.	12.2	40	0	0	0	0	0	0
30	9/29	59°00′N.	141°00′W.	11.7	40	0	0	0	0	0	0
TOTAL					1074	12	121	32	3	1	169

Sets 7 and 8—nine nets rolled.
Set 27—four nets rolled.
Sets 9, 10, and 11—one net rolled.
Set 29—nine nets rolled.
Set 20—lost 28 nets.
Set 30—lost 39 nets.

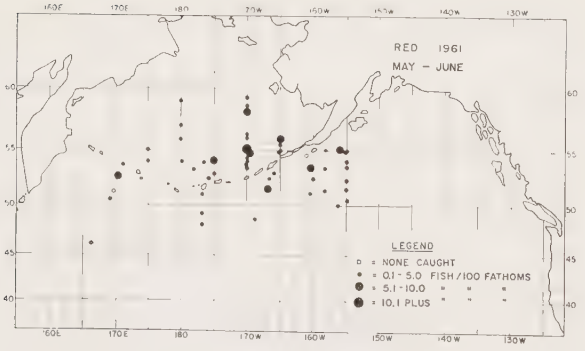

FIGURE 10. Red salmon relative abundance, May and June 1961—2, 3, 4 winters-in-the-sea fish taken in 3-7/8, 4-1/2, 5-1/4-inch mesh nets.

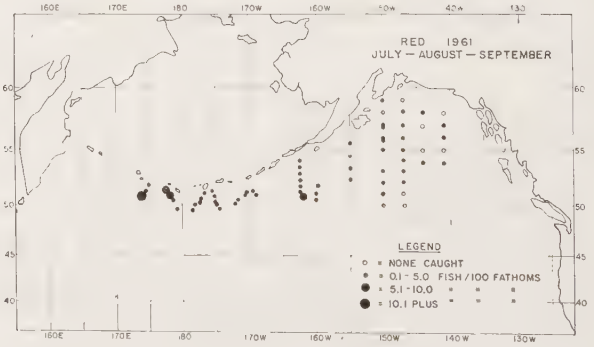

FIGURE 11. Red salmon relative abundance, July, August, and September 1961—2, 3, 4 winters-in-the-sea fish taken in 3-7/8, 4-1/2, 5-1/4-inch mesh nets.

States research vessels in 1961.

Chum						Pink									
Mesh size						Mesh size									
5¼	4½	3⅞	3¼	2½	Total	5¼	4½	3⅞	3¼	2½	Total	Silver	King	Total salmon catch	Steelhead
0	0	0	0	0	0	4	7	0	0	0	11	5	0	16	0
0	0	0	0	0	0	10	7	1	0	0	18	22	0	46	0
3	41	30	13	0	87	1	1	0	0	0	2	6	1	101	5
11	143	60	33	0	247	0	2	0	0	0	2	4	0	260	5
7	80	9	0	0	96	0	1	0	0	0	1	0	0	102	0
2	5	2	0	0	9	0	0	0	0	0	0	0	0	33	0
2	9	11	7	0	29	0	0	0	0	0	0	0	0	75	3
0	7	0	0	0	7	0	0	0	0	0	0	0	0	23	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	13	15	5	0	33	0	0	0	0	0	0	1	0	38	0
0	16	6	1	0	23	0	0	0	0	0	0	0	0	29	2
9	15	1	3	0	28	0	0	0	0	0	0	0	0	39	2
7	131	92	33	2	265	0	0	0	0	0	0	0	0	283	3
3	26	14	0	0	43	0	0	0	0	0	0	2	0	55	1
0	16	3	0	0	19	0	0	0	0	0	0	0	0	20	0
2	12	4	0	0	18	0	3	1	0	0	4	3	0	28	0
0	6	0	1	0	7	0	0	0	0	0	0	2	0	9	1
1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
3	19	8	11	0	41	0	0	0	0	0	0	0	0	42	1
9	60	14	5	0	88	0	0	0	0	0	0	0	0	88	1
3	8	1	0	0	12	0	0	0	0	0	0	0	0	12	0
2	1	1	0	0	4	0	0	0	0	0	0	0	0	6	3
1	3	1	0	0	5	0	0	0	0	0	0	0	0	6	1
1	2	0	0	0	3	0	0	0	0	0	0	0	0	3	0
0	2	0	0	0	2	0	0	0	0	0	0	0	0	4	0
4	3	0	0	0	7	0	0	0	0	0	0	0	0	8	1
2	4	0	1	0	7	0	0	0	0	0	0	1	0	8	3
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	622	272	113	2	1081	15	21	2	0	0	38	46	1	1335	32

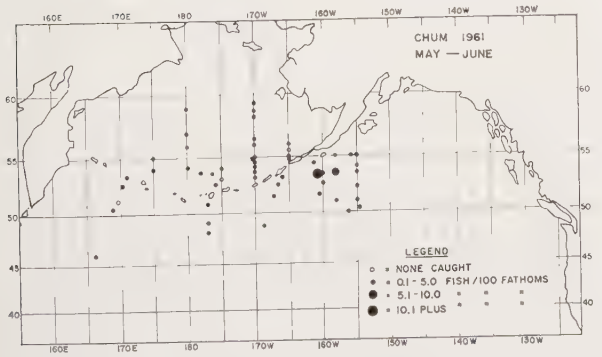

FIGURE 12. Chum salmon relative abundance, May and June, 1961—3, 4, 5, 6-year-old fish taken in 3-7/8, 4-1/2, and 5-1/4-inch mesh nets.

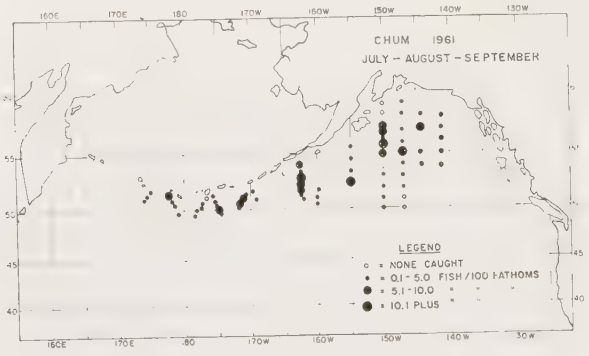

FIGURE 13. Chum salmon relative abundance, July, August, and September 1961—3, 4, 5, 6-year-old fish taken in 3-7/8, 4-1/2, and 5-1/4-inch mesh nets.

TABLE 9. Continued.

MV *Windward* June 5–September 3, 1961.

Set no.	Date	Position		Surf. temp. °C.	Number of shackles	Red Mesh size					Total
		Latitude	Longitude			5¼	4½	3⅞	3¼	2½	
1	6/5	51°47′N.	160°30′W.	6.3	40	9	20	0	0	0	29
2	6/8	53°40′N.	160°24′W.	7.2	40	163	758	18	17	14	970
3	6/10	54°20′N.	161°00′W.	7.0	40	0	0	0	0	0	0
4	6/14	54°52′N.	158°00′W.	8.5	40	0	5	1	0	0	6
5	6/15	55°03′N.	156°00′W.	10.0	40	10	73	0	0	0	83
6	6/16	54°58′N.	155°06′W.	10.3	40	3	24	0	0	0	27
7	6/17	54°05′N.	155°00′W.	9.8	40	0	16	0	0	0	16
8	6/18	53°25′N.	155°00′W.	10.0	40	1	13	0	0	0	14
9	6/19	52°43′N.	154°53′W.	9.5	40	3	18	0	0	0	21
10	6/20	51°45′N.	155°07′W.	8.7	40	3	82	22	10	6	123
11	6/21	50°47′N.	155°07′W.	8.9	40	1	18	12	1	3	35
12	6/22	50°17′N.	156°30′W.	8.7	40	1	9	3	0	0	13
13	6/25	51°22′N.	158°45′W.	9.1	40	3	12	0	1	0	16
14	6/27	51°46′N.	160°05′W.	8.7	40	0	11	1	1	2	15
15	6/28	52°20′N.	160°06′W.	10.2	40	2	18	1	4	5	30
16	6/29	53°11′N.	160°12′W.	9.8	40	0	13	0	0	2	15
17	7/9	54°00′N.	162°30′W.	9.8	40	12	27	8	0	0	47
18	7/10	53°30′N.	162°30′W.	10.8	40	3	17	3	8	4	35
19	7/11	53°00′N.	162°30′W.	11.3	40	2	25	10	11	9	57
20	7/12	52°30′N.	162°38′W.	11.5	40	5	44	18	17	4	88
21	7/13	52°00′N.	162°20′W.	10.5	40	3	46	19	19	3	90
22	7/14	51°30′N.	162°30′W.	10.5	40	0	31	6	4	0	41
23	7/17	51°09′N.	162°07′W.	10.4	40	2	83	24	15	1	125
24	7/25	50°30′N.	160°00′W.	10.8	40	0	42	14	5	0	61
25	7/26	51°15′N.	160°00′W.	11.3	40	4	49	8	5	0	66
26	7/27	52°03′N.	159°44′W.	11.3	40	1	13	3	5	0	22
27	8/7	55°00′N.	157°30′W.	12.1	12	0	1	0	0	0	1
28	8/14	56°00′N.	155°00′W.	10.1	40	0	0	0	0	0	0
29	8/17	55°30′N.	155°00′W.	13.4	33	0	3	0	1	0	4
30	8/21	54°30′N.	155°04′W.	12.8	29	1	10	3	3	0	17
31	8/22	53°30′N.	155°00′W.	12.8	29	0	13	1	0	0	14
32	8/23	52°30′N.	155°00′W.	12.2	29	0	3	0	0	0	3
33	9/2	57°00′N.	150°00′W.	13.3	37	0	8	0	0	0	8
34	9/3	56°05′N.	150°00′W.	12.2	37	0	1	0	0	0	1
TOTAL					1286	232	1506	175	127	53	2093

Set 7—eight nets rolled. Set 14—two nets rolled. Set 27—twenty-eight nets rolled.
Set 28—forty nets rolled. Set 29—three nets rolled. Set 34—twenty nets rolled.
Set 17—nets in water 64 hours due to rough seas.

Chum salmon were taken at nearly every station fished during the spring season. However, dense concentrations of the older chum salmon were not encountered. In the summer season the older chums appeared to be more abundant in parts of the Gulf of Alaska than in the central Aleutians area.

Figures 14 and 15 illustrate the relative abundance of pink salmon for 1961. This year there was only one instance where the catch was more than 10 fish per 100 fathoms of net.

The distribution and relative abundance of juvenile red and chum salmon caught in the 2½ and 3¼-inch mesh nets are portrayed in Figures 16 to 18. The abundance of juvenile red and chum salmon as measured by gillnet catches appeared to be greater in the Aleutian area than in the Gulf of Alaska. It was interesting to note that, although juvenile red salmon were taken at various stations in the spring

Chum						Pink									
Mesh size						Mesh size									
$5\frac{1}{4}$	$4\frac{1}{2}$	$3\frac{7}{8}$	$3\frac{1}{4}$	$2\frac{1}{2}$	Total	$5\frac{1}{4}$	$4\frac{1}{2}$	$3\frac{7}{8}$	$3\frac{1}{4}$	$2\frac{1}{2}$	Total	Silver	King	Total salmon catch	Steelhead
4	8	0	0	0	12	0	3	0	0	0	3	0	0	44	0
41	188	2	1	0	232	0	6	0	0	0	6	0	0	1208	0
0	3	0	0	0	3	0	0	0	0	0	0	0	0	3	0
1	1	0	0	0	2	0	0	0	0	0	0	0	0	8	0
5	29	1	0	0	35	1	2	0	0	0	3	0	0	121	0
5	39	1	0	0	45	0	5	0	0	0	5	0	0	77	0
4	68	0	0	0	72	1	11	0	0	0	12	0	0	100	0
14	52	1	0	0	67	1	22	1	0	0	24	0	0	105	0
12	51	2	0	0	65	1	35	0	0	0	36	0	0	122	0
8	64	3	0	0	75	0	97	10	2	0	109	0	0	307	4
1	13	2	0	0	16	3	35	8	0	0	46	1	1	99	1
2	30	5	0	0	37	2	54	5	1	0	62	0	0	112	3
2	21	0	0	0	23	0	17	1	0	0	18	0	0	57	1
7	127	2	5	0	141	1	83	3	0	0	87	1	0	244	0
0	39	2	0	0	41	15	127	6	0	0	148	3	0	222	0
0	32	0	0	0	32	0	16	0	0	0	16	1	0	64	0
27	70	13	0	0	110	0	6	0	0	0	6	3	0	166	0
10	51	2	0	0	63	1	12	3	0	0	16	2	1	117	0
28	168	18	9	3	226	10	63	5	2	0	80	2	0	365	3
14	130	8	6	0	158	6	76	1	0	0	83	5	1	335	0
3	83	4	2	1	93	2	32	3	0	0	37	1	1	222	0
0	19	13	1	0	33	1	12	0	0	0	13	1	0	88	1
1	40	2	1	0	44	1	8	0	0	0	9	1	1	180	2
3	52	7	12	1	75	1	1	0	0	0	2	5	3	146	3
3	22	5	1	0	31	0	14	0	0	0	14	3	1	115	8
4	14	3	2	0	23	3	28	2	1	0	34	4	0	83	4
0	2	0	0	0	2	0	2	0	0	0	2	0	0	5	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	14	1	0	0	28	2	6	0	0	0	8	2	0	42	3
0	24	4	1	0	29	0	1	0	0	0	1	0	0	47	8
0	20	3	2	0	25	0	1	0	0	0	1	0	0	40	13
9	111	9	2	0	131	2	0	0	0	0	2	0	0	136	4
3	62	7	7	1	80	1	0	0	0	0	1	4	0	93	1
0	9	0	0	0	9	0	0	0	0	0	0	0	0	10	2
224	1656	120	52	6	2058	55	775	48	6	0	884	39	9	5083	61

season, only one juvenile chum was caught (figure not shown).

Salmon Migration

A report on the direction of movement of high seas salmon stocks for 1959 and 1960, as determined from gillnet catches, is being prepared for publication.

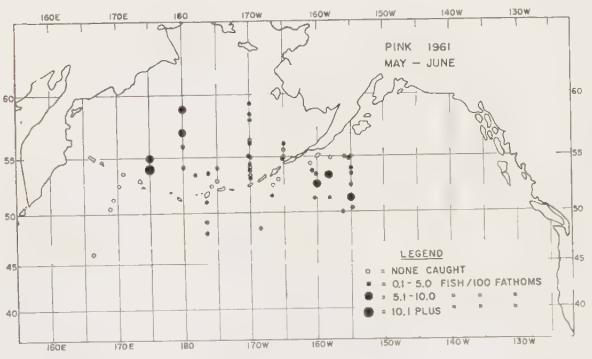

Figure 14. Pink salmon relative abundance, May and June 1961.

TABLE 9. Continued.

MV *Marine View* May 5 August 17, 1961.

Set no.	Date	Position		Surf. temp. °C.	Number of shackles	Red Mesh size					
		Latitude	Longitude			$5\frac{1}{4}$	$4\frac{1}{2}$	$3\frac{7}{8}$	$3\frac{1}{4}$	$2\frac{1}{2}$	TOTAL
1	5/5	55°00′N.	155°00′W.	5.7	40	7	38	1	1	0	47
2	5/14	53°12′N.	165°52′W.	5.3	40	0	14	0	0	0	14
3	5/15	52°26′N.	166°28′W.	5.4	40	12	64	3	0	0	79
4	5/16	51°38′N.	166°48′W.	5.4	40	13	94	2	2	0	111
5	5/21	48°15′N.	168°15′W.	5.9	40	5	24	1	0	0	30
6	5/29	50°57′N.	166°02′W.	4.9	40	7	17	1	2	0	27
7	6/2	49°04′N.	177°03′W.	4.9	40	2	16	0	2	0	20
8	6/3	48°00′N.	176°54′W.	4.5	40	0	6	0	0	0	6
9	6/13	54°00′N.	175°00′W.	5.8	40	10	100	4	1	1	116
10	6/18	53°46′N.	176°37′W.	6.3	40	6	62	5	2	2	77
11	6/19	53°15′N.	178°06′W.	6.2	40	14	54	7	1	0	76
12	6/20	54°00′N.	179°46′W.	5.8	40	5	26	1	0	0	32
13	6/21	56°00′N.	180°	5.3	40	10	41	3	1	0	55
14	6/23	57°00′N.	180°	5.3	40	2	26	1	1	2	32
15	6/25	59°00′N.	180°	4.5	40	6	35	2	0	1	44
16	6/27	55°00′N.	175°00′E.	5.6	40	1	31	2	0	4	38
17	6/28	54°00′N.	175°00′E.	5.9	40	2	27	2	3	1	35
18	7/10	51°18′N.	176°50′W.	8.4	40	0	1	0	0	0	1
19	7/11	50°51′N.	177°18′W.	7.6	40	3	13	5	1	0	22
20	7/12	50°25′N.	177°43′W.	8.0	40	0	19	1	0	0	20
21	7/13	49°57′N.	178°09′W.	7.5	40	0	3	0	0	0	3
22	7/14	49°30′N.	178°34′W.	8.0	40	1	8	0	1	0	10
23	7/15	49°42′N.	179°06′E.	7.5	40	0	7	2	0	0	9
24	7/24	50°35′N.	178°23′E.	7.6	40	1	49	2	3	0	55
25	7/25	51°03′N.	178°04′E.	8.0	40	5	70	36	42	4	157
26	7/26	51°31′N.	177°46′E.	8.8	40	2	120	34	42	9	207
27	7/27	52°00′N.	175°00′E.	8.0	40	6	39	4	3	2	48
28	7/29	51°35′N.	174°27′E.	7.8	40	2	51	27	22	5	107
29	7/30	51°12′N.	173°58′E.	8.0	40	9	187	32	46	4	278
30	8/4	51°30′N.	175°45′W.	9.2	40	1	3	0	1	0	5
31	8/5	51°02′N.	175°27′W.	10.2	40	4	43	16	8	1	72
32	8/6	50°35′N.	175°10′W.	10.0	40	3	30	2	10	0	45
33	8/7	50°07′N.	174°51′W.	9.5	40	2	67	8	10	0	87
34	8/8	49°28′N.	174°35′W.	9.5	40	1	43	8	5	0	57
35	8/10	50°08′N.	172°10′W.	9.8	40	5	19	2	3	0	29
36	8/11	50°35′N.	171°54′W.	10.1	40	4	54	8	10	1	77
37	8/12	51°02′N.	171°37′W.	10.1	40	4	49	8	23	1	85
38	8/13	51°30′N.	171°20′W.	8.7	40	3	8	1	6	3	21
39	8/16	52°02′N.	169°17′W.	10.7	40	0	5	0	4	1	10
40	8/17	51°20′N.	168°30′W.	10.8	40	2	13	7	21	1	44
TOTAL					1600	154	1576	238	277	43	2288

Set 12—one net rolled.

Set 33—two nets rolled.

Set 38—four nets partially rolled.

Chum						Pink									
Mesh size						Mesh size									
5¼	4½	3⅞	3½	2½	Total	5¼	4½	3⅞	3½	2½	Total	Silver	King	Total salmon catch	Steelhead
4	16	1	0	0	21	0	0	0	0	0	0	0	0	68	0
0	3	0	0	0	3	0	0	0	0	0	0	0	0	17	0
1	7	0	0	0	8	0	0	0	0	0	0	0	0	87	0
12	56	0	1	0	69	0	2	0	0	6	2	0	0	182	0
10	41	0	0	0	51	0	4	0	0	0	4	0	1	86	0
1	13	0	1	0	15	0	1	0	0	0	1	0	0	43	0
5	29	6	0	0	40	1	14	0	2	1	18	0	0	78	0
0	32	4	0	0	36	0	12	6	0	0	18	0	0	60	0
1	7	0	0	0	8	0	8	1	0	0	9	0	7	140	0
2	23	1	0	0	26	1	55	6	0	0	62	0	0	165	0
0	7	0	0	0	7	0	16	1	0	0	17	0	0	100	0
0	1	0	0	0	1	1	4	0	0	0	5	0	0	38	0
3	7	0	0	0	10	2	34	4	1	0	41	0	5	111	0
2	7	0	0	0	9	7	74	8	1	0	90	0	6	137	0
2	11	0	0	0	13	9	93	7	0	0	109	0	2	168	0
3	13	1	0	0	17	6	104	1	0	0	111	0	2	168	0
2	41	7	14	1	65	3	165	19	5	0	192	0	0	292	0
0	0	0	0	0	0	0	1	0	0	0	1	0	0	2	0
0	4	1	3	38	46	1	20	1	0	0	22	0	0	90	0
0	12	2	1	2	17	0	32	3	0	0	35	2	0	74	0
0	16	3	4	1	24	0	7	1	0	0	8	2	0	37	0
0	0	1	4	6	11	0	10	0	0	0	10	1	0	32	0
0	4	1	6	5	16	1	3	0	0	0	4	7	0	36	0
1	33	6	18	6	64	0	1	0	0	0	1	45	1	166	2
4	38	9	8	5	64	1	7	1	0	0	9	71	2	303	0
1	89	14	11	20	135	0	24	2	1	1	28	225	2	597	0
1	20	3	28	29	81	0	7	0	0	0	7	7	0	143	0
3	15	0	4	5	27	0	7	2	0	0	9	51	4	198	0
6	31	3	16	8	64	0	6	1	1	0	8	205	0	555	0
1	46	10	6	1	64	0	4	0	0	0	4	7	1	81	0
1	40	3	4	0	48	0	1	0	0	0	1	12	0	133	1
2	48	10	3	0	63	1	0	0	0	0	1	1	1	111	2
1	115	35	3	0	154	0	0	0	0	0	0	8	1	250	5
2	48	7	2	0	59	0	0	0	0	0	0	2	0	118	2
1	36	12	1	0	50	0	0	1	0	0	1	3	2	85	3
4	67	14	2	0	87	0	1	0	0	0	1	2	0	167	1
6	83	19	4	0	112	0	0	0	0	0	0	2	0	199	10
5	61	6	4	0	76	1	2	1	0	0	4	7	0	108	5
7	59	2	3	0	71	0	0	0	0	0	0	1	0	82	0
1	12	2	2	0	17	0	0	0	0	0	0	1	0	62	2
95	1191	183	153	127	1749	35	719	66	11	2	833	662	37	5569	33

TABLE 9. Continued.

MV *Paragon* May 20 June 30, 1961.

		Position				Red Mesh size					
Set no.	Date	Latitude	Longitude	Surf. temp. °C.	Number of shackles	5¼	4½	3⅞	3¼	2½	TOTAL
1	5/20	46°00′N.	166°00′E.	3.1	40	0	5	0	0	0	5
2	5/29	53°21′N.	170°53′E.	4.0	40	10	13	0	0	0	23
3	5/30	52°25′N.	170°14′E.	4.4	40	23	79	10	5	0	117
4	6/1	51°30′N.	169°31′E.	4.1	40	0	0	0	0	0	0
5	6/2	50°35′N.	168°57′E.	4.1	40	4	15	0	0	0	19
6	6/9	52°30′N.	176°00′W.	5.3	40	1	14	1	0	0	16
7	6/10	53°02′N.	175°00′W.	5.3	40	6	14	0	1	1	22
8	6/12	53°25′N.	170°00′W.	6.0	40	3	55	4	3	0	65
9	6/13	54°16′N.	170°00′W.	7.1	40	4	25	0	1	0	30
10	6/14	55°09′N.	170°00′W.	8.3	40	12	212	17	11	2	254
11	6/16	56°11′N.	170°00′W.	6.8	40	8	56	3	1	1	69
12	6/17	57°48′N.	169°58′W.	5.2	40	14	115	9	0	1	139
13	6/18	59°14′N.	169°58′W.	3.7	40	5	8	1	2	0	16
14	6/19	58°20′N.	170°00′W.	4.7	40	6	41	2	1	0	50
15	6/21	56°14′N.	169°58′W.	6.9	40	4	24	1	2	1	32
16	6/22	55°05′N.	170°03′W.	7.0	40	9	131	5	1	0	146
17	6/23	54°27′N.	170°00′W.	7.6	40	2	36	2	2	0	42
18	6/24	53°56′N.	170°01′W.	7.2	40	2	36	12	2	0	52
19	6/25	53°26′N.	169°57′W.	7.1	39	14	41	11	2	3	71
20	6/27	55°00′N.	165°02′W.	7.5	39	0	1	0	0	0	1
21	6/28	55°23′N.	164°58′W.	7.0	39	1	2	0	0	0	3
22	6/29	55°59′N.	165°00′W.	7.2	39	16	134	3	1	0	154
23	6/30	54°59′N.	165°06′W.	6.9	39	6	27	3	0	0	36
TOTAL					915	150	1084	84	35	9	1362
Gulf of Alaska—*Bertha Ann*					1074	12	121	32	3	1	169
Windward					1286	232	1506	175	127	53	2093
TOTAL					2360	244	1627	207	130	54	2262
Aleutian Area—*Marine View*					1600	154	1576	238	277	43	2288
Paragon					915	150	1084	84	35	9	1362
TOTAL					2515	304	2660	322	312	52	3650
GRAND TOTAL					4875	548	4287	529	442	106	5912

Set 1—forty nets rolled. Set 23—nets partially rolled.
Sets 19–23—one shackle of 3⅞-inch mesh not fished.

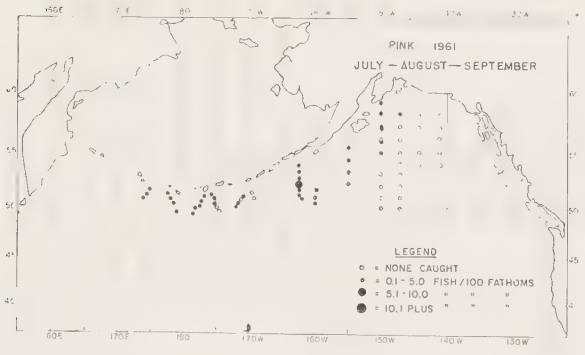

FIGURE 15. Pink salmon relative abundance, July, August, and September 1961.

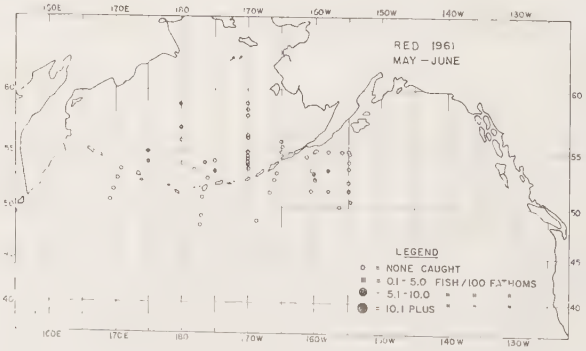

FIGURE 16. Juvenile red salmon relative abundance, May and June 1961—1 winter-in-the-sea fish taken in 2-1/2 and 3-1/4-inch mesh nets.

Chum						Pink									
Mesh size						Mesh size									
5¼	4½	3⅞	3¼	2½	Total	5¼	4½	3⅞	3¼	2½	Total	Silver	King	Total salmon catch	Steelhead
0	2	0	0	0	2	0	0	0	0	0	0	0	0	7	0
5	18	0	0	0	23	0	0	0	0	0	0	0	0	46	0
1	11	0	0	0	12	0	0	0	0	0	0	0	0	129	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	6	0	0	0	6	0	0	0	0	0	0	0	0	25	0
0	1	0	0	0	1	0	0	0	0	0	0	0	1	18	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	0
0	8	0	0	0	8	0	0	0	0	0	0	0	1	74	0
4	11	0	0	0	15	0	0	0	0	0	0	0	1	46	0
18	41	0	1	0	60	0	4	0	0	0	4	0	4	322	0
3	15	1	0	0	19	0	1	1	0	0	2	0	0	90	0
1	11	0	0	0	12	0	1	0	0	0	1	0	0	152	0
8	18	0	0	0	26	0	5	1	0	0	6	0	0	48	0
0	7	0	0	0	7	0	2	0	0	0	2	0	0	59	0
0	5	0	0	0	5	0	0	0	0	0	0	0	0	37	0
5	36	1	0	0	42	0	10	0	1	0	11	0	4	203	0
4	21	0	0	0	25	1	17	1	0	0	19	0	0	86	0
1	10	2	0	0	13	4	6	0	0	0	10	0	0	75	0
7	52	6	1	0	66	1	15	1	0	0	17	0	0	154	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
2	12	0	0	0	14	0	1	0	0	0	1	0	0	169	0
1	7	0	0	0	8	0	2	1	0	0	3	0	0	47	0
60	292	10	2	0	364	6	64	5	1	0	76	0	11	1813	0
72	622	272	113	2	1081	15	21	2	0	0	38	46	1	1335	32
224	1656	120	52	6	2058	55	775	48	6	0	884	39	9	5083	61
296	2278	392	165	8	3139	70	796	50	6	0	922	85	10	6418	93
95	1191	183	153	127	1749	35	719	66	11	2	833	662	37	5569	33
60	292	10	2	0	364	6	64	5	1	0	76	0	11	1813	0
155	1483	193	155	127	2113	41	783	71	12	2	909	662	48	7382	33
451	3761	585	320	135	5252	111	1579	121	18	2	1831	747	58	13800	126

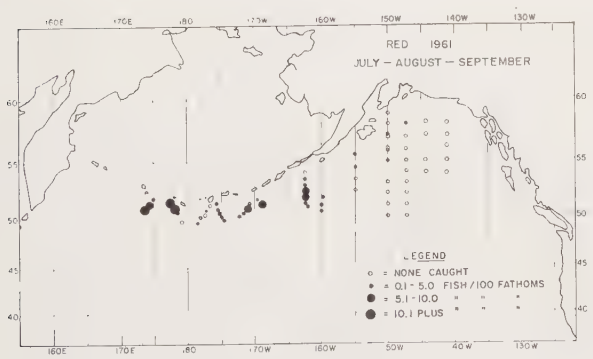

FIGURE 17. Juvenile red salmon relative abundance, July, August, and September 1961—1 winter-in-the-sea fish taken in 2-1/2 and 3-3/4-inch mesh nets.

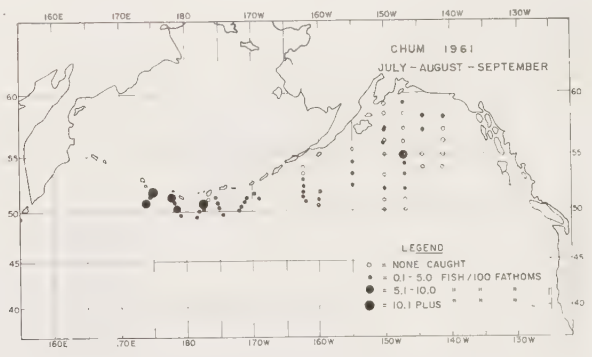

FIGURE 18. Juvenile chum salmon relative abundance, July, August, and September 1961—2-year-old fish taken in 2-1/2 and 3-1/4-inch mesh nets.

OCEANOGRAPHY

by Felix Favorite and B. A. Morse

Field Work

Physical, chemical and biological observations, similar to those obtained in previous years, were made aboard chartered vessels *Paragon*, *Marine View*, and *Windward* at fishing locations (Fig. 19).

Zooplankton investigations were conducted aboard the USC&GS vessel *Pioneer* during a cruise from Honolulu to the Aleutian Islands and return (Fig. 20). These observations will permit comparison of the abundance of food organisms in salmon waters (northward of lat. 40°N.) with the food organisms in the region to the southward, and investigations of the type and abundance of organisms in the Intermediate Water. The latter water mass, identified by a salinity minimum ($<34.0^{0}/_{00}$) occurring at depth between the surface lens of Pacific Central Water and the Deep Water (Favorite and Hebard, 1960), is believed to originate in the Okhotsk Sea and may influence the distribution and movements of the salmons. Although the water mass exists at depth, it is continuous across the North Pacific Ocean southward of latitude 40°N. *In situ* temperatures of 4° to 8°C., and dissolved oxygen values of .2 to .4 mg. at./L seem to provide an acceptable salmon environment.

Physical Oceanography

The oceanographic data collected during 1939 to 1941 in Bristol Bay (Favorite *et al.*, 1961) have been analyzed. A description of oceanographic conditions and features in the Bay has been completed and will be included in the Joint Report on Oceanography being prepared for the Committee on Biology and Research. The general counter-clockwise circulation in the Bay is widely recognized, but there appears to be an active upwelling zone at the entrance of the Bay between Cape Peirce and Port Moller. This is reflected in data collected during Summer, 1940, by

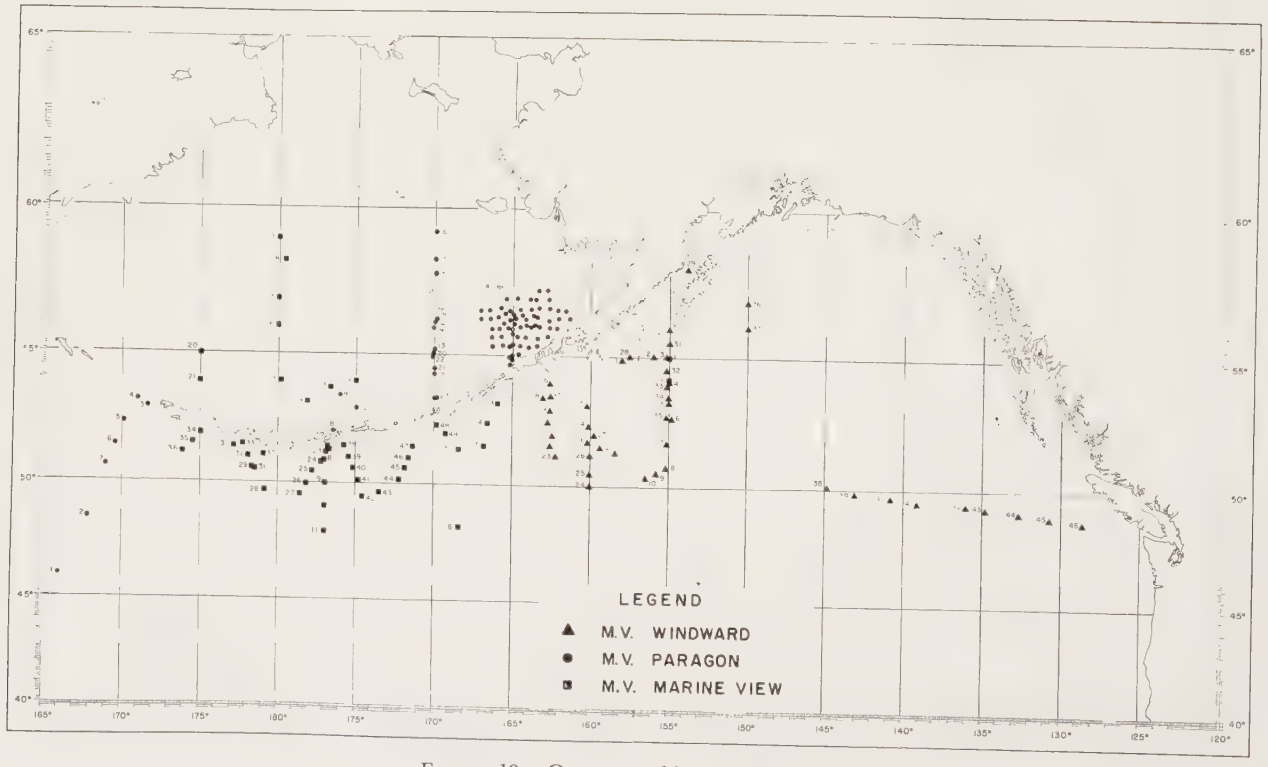

Figure 19. Oceanographic stations, 1961.

high surface salinity values (31.8 and 31.9‰) shown in Figure 21, and the feature is found for all years in which adequate data are available in this area.

The Joint Report on Oceanography will summarize conditions, features, and processes revealed through analyses of data collected by members of INPFC and other agencies. During the past year, we have investigated the possibility of predicting oceanographic conditions in salmon waters. Volume transport data from 0 to 1200 meters computed from hydrographic observations made during Summer 1958 were interpolated to obtain values across the boundaries of 5° squares of latitude and longitude over the North Pacific Ocean northward of latitude 35°N. These values were compared with geostrophic mass transports computed from wind stress measurements for July and August (Fofonoff, 1960) which were treated in the same manner. For convenience, transport in the westward flowing Alaska Boundary Current was contained south of the Aleutian Islands until longitude 175°E. The general agreement in zonal and meridional components of transport (Figs. 22 and 23) is encouraging, but improvements in both methods

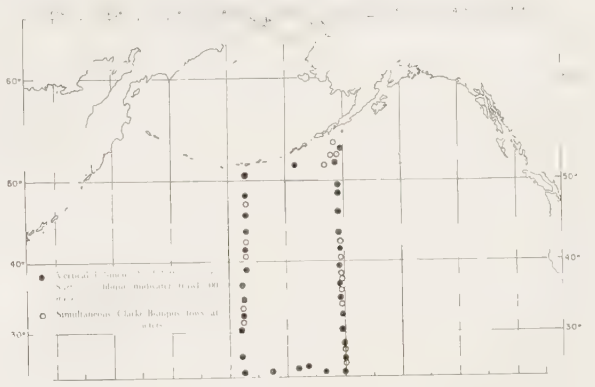

FIGURE 20. Location of zooplankton observations made aboard the USC and GS vessel *Pioneer* during September and October 1961.

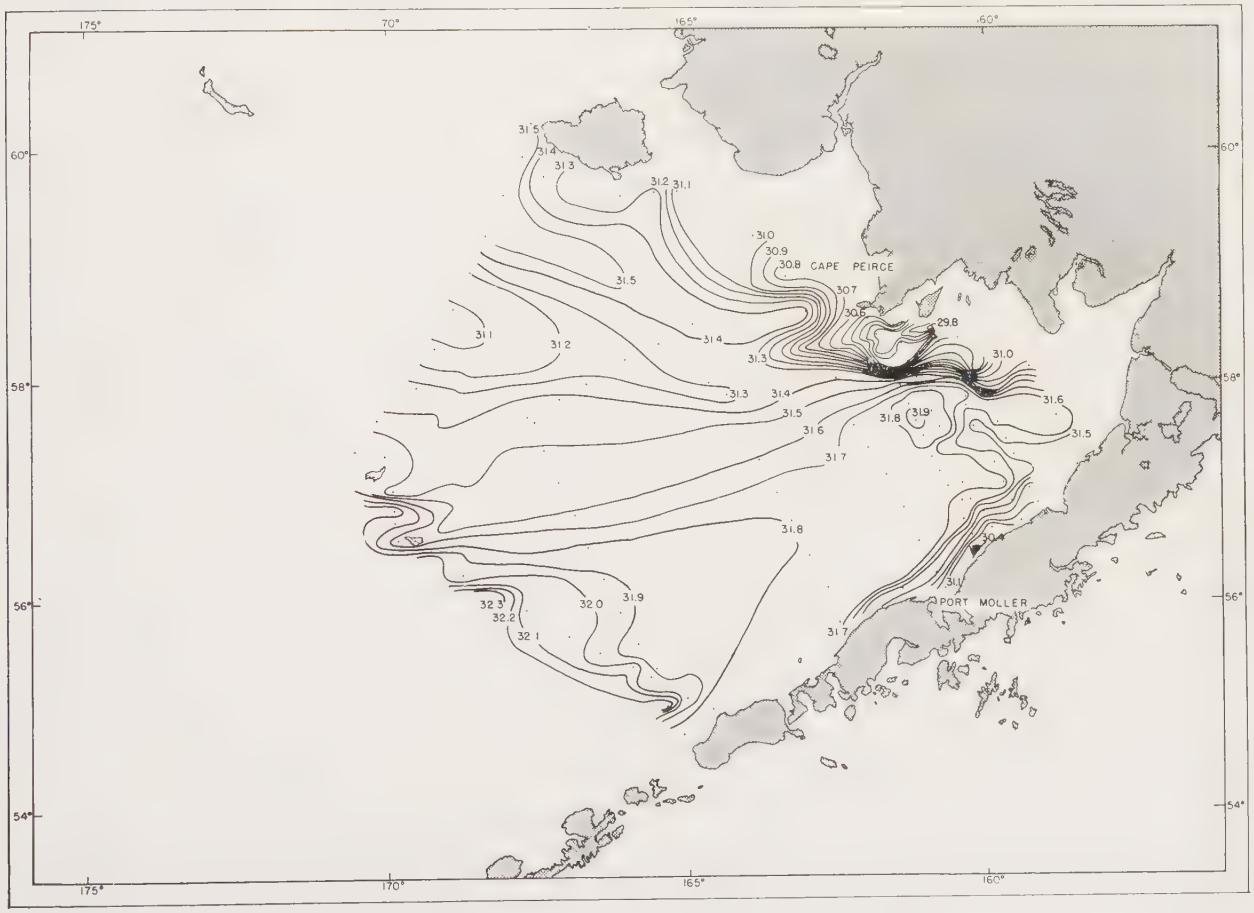

FIGURE 21. Surface salinity, Summer 1960.

of computation are necessary before they can be effectively compared, or the latter considered a reliable method of predicting conditions. First, a valid reference level for the volume transports must be ascertained by means of direct current measurements; and second, several theoretical considerations in the mass transport data require further study. One important consideration is the fact that the geostrophic mass transport for each month is computed from wind stress derived from average sea level pressures that occurred during that month, and the induced inertia of the ocean is not carried over to the next month. It should be pointed out that the data were not derived specifically for the above predictive purpose. Nevertheless, they are a significant contribution to our knowledge of the possible effects of wind stress on the circulation, and could permit presentations of oceanic transport across the Pacific Ocean impossible to obtain by research vessels. Since the transport data do not reveal the extent of individual water masses discussed in previous annual reports, it may be necessary to devise a system of moored buoys to obtain this information.

Considerable progress has been made on the Joint Report on Oceanography and we anticipate that the manuscript will be completed by March 1962.

Instrumentation. As we add to our knowledge of oceanographic conditions and possible relationships to the salmons, it becomes increasingly more desirable to determine the *in situ* conditions while aboard the vessel so that particular environments may be sought out, or changes in environmental conditions between fishing sets are recognized. Since our experiments in 1958 to ascertain surface salinities by means of a conductivity device towed astern of the vessels, we have tried to find an inexpensive, compact, reliable device that would permit analysis of water samples aboard the chartered vessels which usually do not have laboratory space. The new IMC salinometer presently used for analyses in the laboratory is capable of shipboard operation, but the unit is too expensive to permit placing one aboard each chartered fishing vessel.

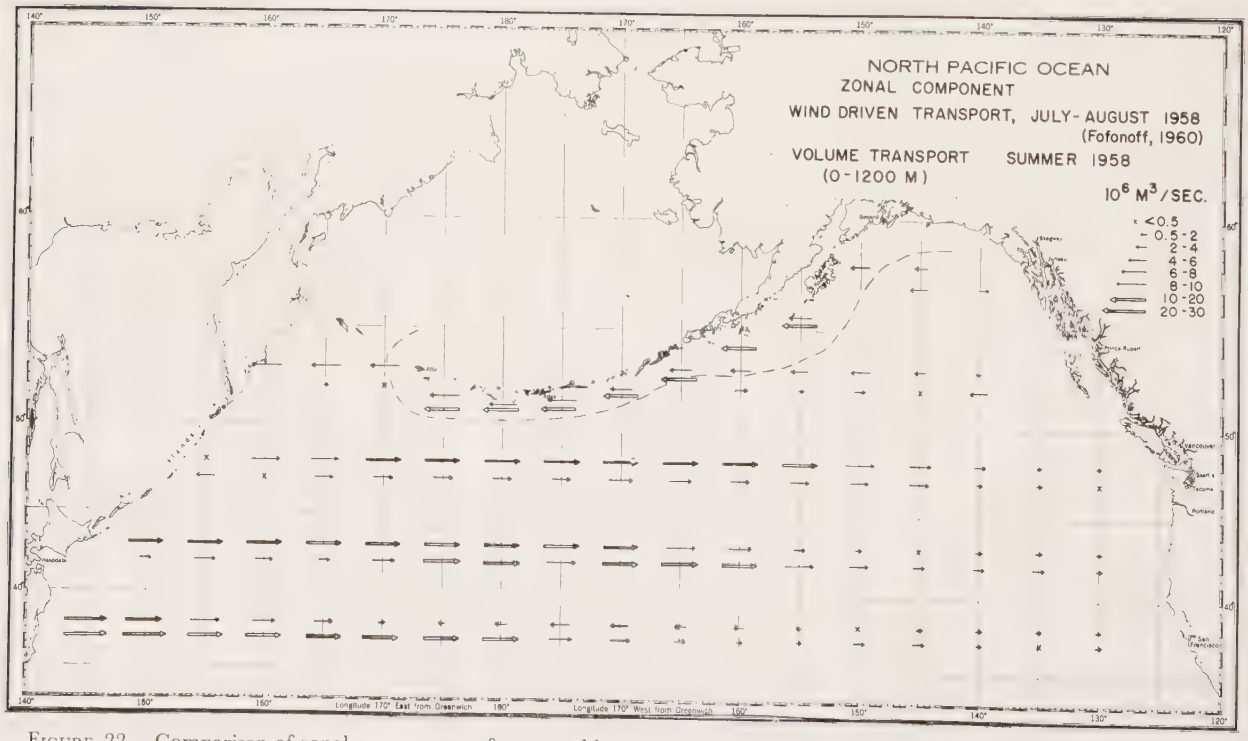

FIGURE 22. Comparison of zonal components of geostrophic mass transport computed from wind stress (upper arrow in each set) and volume transport computed from hydrographic data from 0 to 1200 meters (lower arrow in each set) during Summer 1958. (Dashed line shows approximate extent of Alaska Boundary Current.)

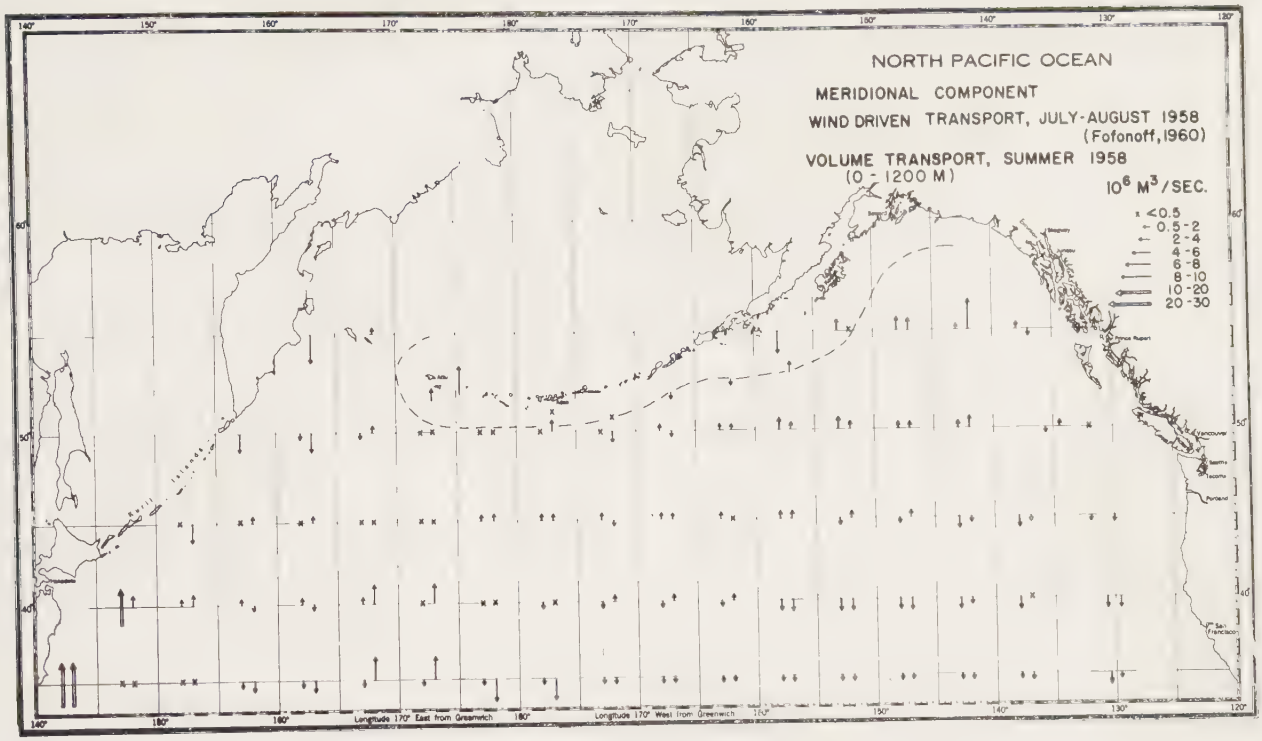

FIGURE 23. Comparison of meridional components of geostrophic mass transport computed from wind stress (left arrow in each set) and volume transport computed from hydrographic data from 0 to 1200 meters (right arrow in each set) during Summer 1958. (Dashed line shows approximate extent of Alaska Boundary Current.)

We are presently evaluating a differential refractometer and will also test an inductive salinometer, both of which appear to fulfill our requirements at this time. The differential refractometer provides precision and accuracy comparable with conductivity salinometers presently in use. The sample and reference cells have small volumes, and little maintenance is required for the instrument. The inductive salinometer also is portable, does not require a temperature-controlled bath, and has accuracy of approximately 0.003 parts per thousand.

Biological Oceanography

All plankton data collected prior to 1961 have been placed on IBM cards to permit qualitative and quantitative comparisons between individual years, and to investigate relationships between the plankton captured by net and the contents of red salmon stomachs.

In 1960 and again in 1961, studies on the vertical distribution of plankton have been made at three locations in the Subarctic Region. Results show that maximum concentrations of plankton occur between 30 to 50 meters depth at night and at depths of 150 meters or greater during the day. This places considerable doubt on the generally accepted theory that salmons come to the surface in the evening or morning to feed. Night light studies have shown that squid are abundant at the surface in this Region, but we do not know whether or not they are attracted to the surface by the light. Comparisons of the plankton and the stomach content of salmon caught at these locations, and investigations into relationships between the plankton and the thermocline are being carried out.

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SALMON SEROLOGY

by George J. Ridgway and Fred M. Utter

Among the methods being applied to the problem of determining the amount of intermingling of Asian and American stocks of salmon in high seas areas are various serological or immunochemical methods. These methods are used to detect characteristic antigenic differences which may occur in different frequencies in genetically isolated populations.

The research which we have conducted includes research on cellular antigens, serum antigens and studies on the use of antigenic and histological changes as indicators of the onset of sexual maturation.

Research on Cellular Antigens

Our studies on the antigens of red blood cells of red, chum, and pink salmon were continued and expanded in the 1961 season. More intensive sampling in the Bristol Bay area and the use of a much larger number of reagents allowed us to make several important demonstrations of antigenic variations between areas. Samples were also taken and tested aboard the chartered vessel MV *Bertha Ann*, allowing us to demonstrate the feasibility of conducting many of our tests and procedures on the high seas when a vessel with sufficient room is available. In addition to Western Alaska areas, the Fraser, Skagit and Columbia River fisheries were sampled and tested extensively.

The sources of the agglutinins used in these studies were heterimmune sera, normal sera, isoimmune sera and phytoagglutinins from plant extracts. Among the immune antisera tested, eight goat anti-salmon tissue sera, four carp anti-salmon red blood cell sera, seventeen chicken anti-salmon red blood cell sera, four carp anti-red cell sera, and five rainbow trout isoimmune sera demonstrated at least some degree of intra- or inter-specific differentiation. Ten rabbit anti-salmon tissue sera and a number of other sera of diverse origin did not detect differences.

The phytoagglutinins used included over thirty-five extracts, many of which reacted strongly. Extensive testing under controlled conditions tended to place in doubt interpretations of observable differences using several of the extracts—principally extracts of baby lima bean—as the results were often not repeatable and appeared to vary with age of cell samples. Several extracts appear to show antigenic variation of a consistent nature, including *Wistaria floribunda* bark, red kidney bean, and *Cytisus scoparius* bark. *Cytisus* appears the most promising at present and has been tested against cells from various areas with good demonstration of variability between populations of red salmon (see Table 10).

Table 10. The relative numbers of red salmon from several areas giving different reactions with *Cytisus scoparius* bark extract.

River	Agglutination score			Total number tested	Mean score
	0	0.5–2	2–5+		
Branch River	2	34	11	47	1.86
Kenai River	8	12	0	20	0.675
Karluk River	0	14	11	25	2.60
Fraser River	24	7	1	32	0.453
Columbia River	5	3	2	10	1.05

Normal sera from many species of land animals and fishes have been extensively tested. One hundred and ten different land animal sera were provided and tested by Dr. C. Stormont. These include sera from a wide variety of species obtained at the San Diego Zoo and numerous sera from domestic animals. In addition, twenty-five normal horse sera, sixteen normal rabbit sera, English sole sera, crayfish sera, and others have been extensively tested. In general, these tend to demonstrate strong inter-specific antigenic differentiation, but intraspecies differences to a lesser extent.

Isoimmune antisera testing has been limited to sera from rainbow trout. Five have shown clear intra-specific differentiation in red salmon and marked differences between populations even within Bristol Bay (Table 11). Several have also demonstrated intraspecific antigenic variability in pink and chum salmon. We consider this the most important advance made so far in our work, since isoimmune sera are known to detect far greater numbers and finer antigenic differences than other sources of blood typing reagents. In addition, these sera show the most striking and consistent differences of any of the reagents we have so far tested. Some of the properties of these sera and the methods used in their preparation were described in a paper presented to the New York Academy of Sciences at a symposium on "Blood Groups in Infra-human Species".

TABLE 11. The relative numbers of red salmon from six Bristol Bay streams reacting with two rainbow trout isoimmune sera.

Serum	Area	Number tested	Number reacting	Percent reacting
96	Kvichak	72	42	58.3
	Branch River	25	8	31.2
	Wood River	10	2	20.0
	Egegik	16	4	25.0
	Ugashik	12	3	25.0
	Naknek	12	5	41.7
		$X^2 = 12.82$*		
101	Kvichak	72	46	63.9
	Branch River	25	17	68.0
	Wood River	10	5	50.0
	Egegik	16	8	50.0
	Ugashik	12	12	100.0
	Naknek	12	11	91.7
		$X^2 = 13.07$*		

* Significant at the 95 percent level.

The application of these sera directly to the Protocol problem will undoubtedly require testing blood from freshly caught salmon in Asian areas and in areas of suspected intermingling of Asian and American stocks. (This is due to the fact that salmon blood cells are not preserved intact for any appreciable time by techniques presently available.) The relative availability of fresh blood from salmon caught by North American shore based fisheries allows us to apply these sera now to problems important to the understanding and management of these fisheries.

Research on Serum Antigens

The demonstration of characteristics designated antigens I and II which were present in 95 to 98 percent of red salmon blood samples tested from American areas and absent from 85 to 90 percent of red salmon blood samples tested from Asian areas has been reported previously. Further practical expansion of these results has met with difficulties of two sorts. The first involves the difficulty in producing sufficient antisera of the same specificity to test large numbers of samples. The second difficulty involves the resolution of apparent discrepancies between the results obtained with this method and those obtained with other methods of determining the continental origin of red salmon taken in the high seas.

In our report of last year we stated: "We feel it is essential to make a more thorough study of the nature of the difference being detected, and the effect of such variables as may be introduced by sampling and preservation methods, before further application of this method is possible. It will also be essential to perfect methods for the consistent production of large quantities of potent and specific antisera." In our attempts to solve the problems of antiserum production we have immunized 50 rabbits and collected and tested serum from 250 bleedings. Of these sera 122 show definite individual differences. We are conducting extensive tests by several methods to compare the specificities of these sera with those detecting previously studied differences. One of the methods being used for these comparisons is immunoelectrophoresis. A separate manuscript describing some of our results with immunoelectrophoresis will be submitted. One most significant finding so far is that the interaction of the hemoglobin in hemolysed blood under certain conditions can interfere with the tests for important serum components. This is especially true of three serum characters discovered after antigens I and II. These have been designated H, H′ and C. We have been and are studying this problem intensively by a variety of methods. For two years now personnel of the serology investigations have accompanied charter vessels to collect separated serum samples and study the feasibility of conducting some of our tests on board these vessels. All of our work indicates that facilities must be available on research vessels to operate centrifuges, separate the serum from fresh unhemolysed blood, and conduct agglutination tests directly on board before we will be able to accurately apply the reagents we have available to the study of high seas populations.

Certain plant extracts have been found to precipitate soluble components of various fish sera in a manner analogous to immune sera. Among these, four have demonstrated individual variation in various salmonid species. The specificities of these reagents when compared by double diffusion have been found to be independent of one another as well as independent of the specificities of immune reagents tested. Although extensive tests with these reagents have not been made, further study on properly preserved samples may show that the serum components detected by these plant extracts are useful racial markers.

Research on Maturation in Salmon

We have previously reported the discovery of an antigenic fraction which apparently occurs in the serum of only maturing or mature female salmon. In the past year we have tested the heart blood from 2,955 chum salmon being processed by the morphology

laboratory. Of these fish 619 were taken by the U.S. chartered research vessel MV *Pioneer* in 1959 and 686 taken by the same vessel in 1960; 1,510 were taken by the U. S. chartered research vessel MV *Paragon* in 1960 and 138 were taken by Japanese vessels in 1959. Of these, 1,608 were females and 815 gave positive tests for the female maturity (Sm) antigen.

Table 12. The correlation of gonad weight with presence of Sm antigen in the sera of female chum salmon.

Gonad weight (gr.)	Total females tested	Number positive	Percent positive
<8	165	8	4.9
8–9	121	22	18.9
10–11	71	18	25.4
12–13	90	34	37.8
14–15	21	7	33.3
16–17	14	8	57.1
18–19	14	10	71.1
≥20	253	250	98.8

Table 12 shows the correlation between gonad weight and the possession of Sm antigen by female chum salmon. If the possession of the Sm antigen is a good indicator of maturation one can be quite certain that a female chum salmon with gonads weighing 20 or more grams is maturing. For those with gonads weighing less than 20 grams there is considerable uncertainty which possibly can be resolved by tests for the Sm antigen.

In order to have additional criteria for maturity in salmon, we collected and fixed gonad samples aboard the MV *Paragon* in 1960 for histological studies. These studies were conducted by Dr. E. M. Wood and a manuscript describing the results is being submitted. They may be summarized as follows: Maturing salmon gonads pass through a series of structurally well defined stages. Active spermatogenesis and the onset of sexual maturation appears to begin when the first spermatogonia are formed. Active oogenesis apparently starts with the formation of secondary oocytes and the appearance of the two layered zona radiata.

Summary

1. Research on serology has been continued along three main lines in studies on red blood cell antigens, serum antigens and on maturity.

2. In the studies on red blood cell antigens a great many additional reagents have been studied. These include heterimmune sera produced in rabbits, chickens, goats and carp; normal sera of many domestic and wild mammals and fish; isoimmune sera produced in rainbow trout; and phytoagglutinins from plant extracts.

3. Clear cut qualitative intraspecific variations in the blood cell antigens of red, pink and chum salmon were demonstrated with five rainbow trout isoimmune sera. Significant differences among Bristol Bay populations of red salmon were demonstrated with two of these sera.

4. In studies of serum antigens 50 rabbits were immunized and serum from 250 bleedings collected and studied. Of these 122 gave evidence of individual differences in red salmon. Evidence was obtained which indicated that the presence of hemoglobin in lysed blood preparation influences the tests for some variable serum components.

5. The method of immunoelectrophoresis was adapted to the study of serum antigens of salmon.

6. Certain plant extracts were found to specifically precipitate with salmon sera. Some detect interspecific and intra-specific differences.

7. In order to assist in determining the maturity of salmon collected on the high seas, the heart bloods of 2,955 chum salmon have been tested for the presence of an antigen which occurs in the blood of maturing females.

8. A study of the histology of salmon gonads has been made to assist in establishing criteria for maturity.

MORPHOLOGICAL CLASSIFICATION OF 1960 RED SALMON

by B. J. Landrum and T. Dark

Since 1955, the morphological differences between the principal races of red salmon were examined using multivariate analytical techniques. On the basis of the results from tagging, parasite studies and distance function analysis of morphological characters, it was concluded that the maturing red salmon in the

waters north and south of the Aleutian Islands were either of western Alaskan or southwest Kamchatkan origin. Consequently, discriminant function analysis was utilized to estimate the proportions of western Alaskan and southwest Kamchatkan morphotypes in high seas samples collected in 1956 and 1957 (Fukuhara *et al.*, 1959). Results of similar classificatory procedure using the 1958 and 1959 samples were presented by Fukuhara (1960).

This report presents the results of classifying the high seas samples taken in the North Pacific Ocean and Bering Sea in 1960.

Classification of 1960 Samples

The red salmon runs into Bristol Bay were extremely large in 1960. The total was given as about *37 million fish* by Royce (1961). It is reasonable to assume that prior to their arrival in the Bay, these same fish dominated the maturing red salmon populations in large areas of the North Pacific Ocean and Bering Sea. Particularly in the eastern Bering Sea (east of 180° longitude) it is reasonable to assume that during the period of sampling, Bristol Bay stocks totally dominated. This condition provides a unique circumstance to evaluate the efficiency with which the discriminant function classifies western Alaskan salmon taken on the high seas. Under these circumstances, if the discriminant function as applied is efficient, the fish in all samples of matures taken in the eastern Bering Sea should classify almost entirely as Bristol Bay morphotype. Deviations from this probably can be best interpreted as a result of the random sampling variation which occurs in sampling Bristol Bay stocks at sea.

In 1960, inshore sampling was limited to six principal streams in Bristol Bay. As in past years, samples were obtained from the Wood, Kvichak, Naknek, Egegik and Ugashik Rivers. In addition, a sample was obtained from the Branch River which flows into Kvichak Bay. No samples were available from the Kamchatkan mainland (as in 1959) or from the Okhotsk Sea (as in years prior to 1959).

High seas sampling was comparatively good in the eastern Bering Sea but rather poor in the western Bering Sea. Sampling in the Aleutian region of the North Pacific Ocean was fair north of 50°N. latitude. Very few samples, however, were obtained south of this latitude or in the southwest Aleutian region.

In the absence of samples from the Kamchatka Peninsula or the Okhotsk Sea, it was necessary to select samples from an alternative area southeast of the Kamchatka Peninsula and west of 165°E. longitude to represent the Kamchatkan population. Of the available samples only those containing greater than 100 specimens were selected. These samples were collected on June 3, June 18 and July 6 at 52°37′N. latitude, 164°18′E. longitude; 53°13′N. latitude, 164°44′E. longitude; and 49°22′N. latitude, 162°43′E. longitude, respectively. Using gonad weight criteria (Ishida and Miyaguchi, 1958), these samples were observed to be 98, 92 and 94 percent mature fish. Considering that these fish were on their spawning migration, it is a reasonable assumption that they were samples of Kamchatkan red salmon, for the area and time of capture make it very improbable that they were Bristol Bay salmon. All evidence from past research has indicated that the area in which these samples were taken contained predominantly mature Kamchatkan red salmon (International North Pacific Fisheries Commission, 1960).

Assuming that the maturing red salmon in the high seas areas sampled were either of Bristol Bay or Kamchatkan origin, the discriminant function, constructed on the basis of the 1956 collection (Fukuhara *et al.*, 1959), was applied to the 1960 collection. Using the average errors of misclassification of the 1960 Bristol Bay inshore samples and the Kamchatkan reference samples, the corrected percentages of the two types present in the high seas samples were calculated. The average error of misclassification of Bristol Bay salmon was weighted according to the relative abundance of red salmon in principal Bristol Bay streams as estimated from escapements.

Table 13. Average error of classification weighted according to the relative abundance of the contributing stocks of western Alaskan red salmon in 1960.

Area	Escapement in millions in 1960	Relative abundance	Observed percent of misclassification	Weighted value
Egegik River	1.798	.0824	29.1	2.3978
Ugashik River	2.304	.1056	20.7	2.1859
Kvichak River	14.630	.6706	16.6	11.1320
Wood River	1.016	.0466	28.2	1.3141
Naknek River	.828	.0380	38.3	1.4554
Branch River	1.240	.0568	57.6	3.2717
Total	21.816	1.0000		21.7569

Average errors in classification:

For the western Alaskan population (Pa) = 21.7569%

For the Kamchatkan population

$$(Pb) = \frac{22.5 + 21.8 + 34.9}{3} = 26.4000\%.$$

The average error of misclassification, weighted according to the relative abundance of the Bristol Bay red salmon population, was 21.8 percent (Table 13). This error of misclassification falls between a relatively small error (17.8 percent) in 1956-1957 and larger errors in 1958 (22.6 percent) and 1959 (23.6 percent). The Branch River which was not used in previous analyses contributed 5.68 percent of the Bristol Bay escapement. The single sample obtained from this river had a rather large percentage of misclassified specimens which increased the average error of misclassification.

The average error of misclassification of the Kamchatkan samples was 26.40 percent. Previously the Kamchatkan error of misclassification was about 23.7 percent for the Okhotsk Sea samples in 1956–1957, 29.1 percent in 1958, and 36.6 percent in 1959, for a sample from the Ozernaya River.

TABLE 14. Results of discriminant function analysis, 1960 high seas red salmon samples.

Sample number	Sampling date	Position of sample		Sample size	Percent classified		Corrected percent western Alaskan type	90 percent confidence interval[1]	Percent mature
		Latitude	Longitude		Western Alaskan type	Kamchatkan type			
1	7/14	49°59′N.	160°50′E.	42	40.48	59.52	27.2	3–51	90
2	7/6	49°22′N.	162°43′E.	109	34.86	65.14	16.3	2–31	94
3	6/3	52°37′N.	164°18′E.	119	21.85	78.15	0	0–13	98
4	6/18	53°13′N.	164°44′E.	111	22.52	77.48	0	0–13	92
5	7/11	50°46′N.	166°48′E.	117	31.62	68.38	10.1	0–24	88
6	5/28	46°32′N.	167°47′E.	233	37.77	62.23	21.9	12–32	96
7	6/6	48°00′N.	168°00′E.	55	32.73	67.27	12.2	0–32	—
8	6/10	54°06′N.	169°43′E.	48	47.92	52.08	41.5	19–64	—
9	5/30	52°00′N.	170°00′E.	36	44.44	55.56	34.8	8–61	100
10	5/28	50°07′N.	170°04′E.	57	47.37	52.63	40.4	19–61	93
11	7/8	49°00′N.	170°06′E.	47	29.79	70.21	6.5	0–28	19
12	5/30	52°42′N.	171°37′E.	117	40.17	59.83	26.6	12–41	97
13	7/16	52°22′N.	172°50′E.	118	58.47	41.53	61.9	48–76	4
14	7/19	51°20′N.	173°00′E.	54	50.00	50.00	45.5	24–67	7
15	7/17	52°00′N.	173°00′E.	78	56.41	43.59	57.9	40–76	5
16	7/18	51°39′N.	173°02′E.	120	53.33	46.67	51.9	37–66	6
17	6/28	59°41′N.	173°42′E.	115	30.43	69.57	7.8	0–21	93
18	6/29	50°59′N.	174°55′E.	76	40.79	59.21	27.8	10–46	19
19	6/30	50°01′N.	175°03′E.	98	38.78	61.22	23.9	8–40	14
20	6/8	53°37′N.	175°54′E.	38	71.05	28.95	86.1	63–100	89
21	8/1	50°20′N.	178°00′E.	117	64.96	35.04	74.4	60–88	2
22	7/28	51°00′N.	178°00′E.	160	71.25	28.75	86.5	75–98	2
23	7/27	51°20′N.	178°00′E.	123	70.73	29.27	85.5	72–98	12
24	7/29	50°39′N.	178°02′E.	116	58.62	41.38	62.1	48–77	5
25	6/23	54°57′N.	179°23′E.	40	67.50	32.50	79.3	56–100	100
26	6/5	50°02′N.	179°59′E.	49	57.14	42.86	59.3	37–82	92
27	6/6	51°00′N.	179°59′E.	115	69.57	30.43	83.3	70–97	100
28	7/3	50°02′N.	178°36′W.	45	57.78	42.22	60.5	37–84	6
29	6/7	51°04′N.	178°30′W.	118	82.20	17.80	100.0	88–100	92
30	6/15	53°17′N.	178°17′W.	119	84.03	15.97	100.0	88–100	100
31	6/19	54°03′N.	177°05′W.	168	82.14	17.86	100.0	90–100	98
32	6/20	55°01′N.	176°58′W.	121	85.95	14.05	100.0	88–100	100
33	6/18	53°00′N.	176°58′W.	111	88.29	11.71	100.0	88–100	98
34	7/4	51°20′N.	176°45′W.	83	62.65	37.35	69.9	53–87	27
35	8/14	51°28′N.	176°30′W.	170	67.06	32.94	78.4	67–90	10
36	8/17	51°00′N.	176°30′W.	145	64.83	35.17	74.1	62–87	3
37	8/18	50°40′N.	176°30′W.	151	62.91	37.09	70.4	58–83	2
38	8/20	50°20′N.	176°30′W.	134	67.16	32.84	78.6	66–92	1
39	6/15	53°00′N.	176°10′W.	115	81.74	18.26	100.0	88–100	100
40	6/28	58°28′N.	176°07′W.	121	74.38	25.62	92.5	80–100	96

Continued . . .

TABLE 14. (continued)

Sample number	Sampling date	Position of sample		Sample size	Percent classified		Corrected percent western Alaskan type	90 percent confidence interval[1]	Percent mature
		Latitude	Longitude		Western Alaskan type	Kamchatkan type			
41	6/16	54°01′N.	175°38′W.	113	84.96	15.04	100.0	88 100	100
42	6/18	56°01′N.	175°00′W.	61	70.49	29.51	85.0	66 100	97
43	5/29	45°00′N.	175°00′W.	56	66.07	33.93	76.5	56-97	2
44	6/19	57°01′N.	174°59′W.	43	83.72	16.28	100.0	80 -100	73
45	6/20	56°42′N.	173°27′W.	120	75.83	24.17	95.3	83-100	100
46	7/11	51°29′N.	173°04′W.	130	60.00	40.00	64.8	51–78	32
47	7/12	51°09′N.	173°01′W.	100	64.00	36.00	72.5	57 88	36
48	7/15	50°29′N.	173°00′W.	31	54.84	45.16	54.9	26 83	14
49	7/7	53°44′N.	173°00′W.	48	64.58	35.42	73.6	52–96	71
50	7/13	50°50′N.	172°59′W.	68	54.41	45.59	54.0	35–73	22
51	6/28	50°07′N.	171°43′W.	83	55.42	44.58	56.0	39–73	12
52	6/21	56°21′N.	171°41′W.	117	76.92	23.08	97.4	85–100	99
53	5/24	50°06′N.	171°40′W.	85	72.94	27.06	89.8	74–100	93
54	5/23	51°04′N.	170°49′W.	114	78.07	21.93	99.7	87–100	100
55	6/27	51°18′N.	170°37′W.	69	68.12	31.88	80.5	63 93	56
56	7/19	51°13′N.	170°02′W.	116	58.62	41.38	62.2	48 77	8
57	7/18	50°54′N.	170°02′W.	167	56.29	43.71	57.7	45–70	18
58	6/23	55°00′N.	170°01′W.	93	76.34	23.66	96.3	82–100	100
59	7/20	51°32′N.	170°01′W.	112	67.86	32.14	80.0	66 94	40
60	7/23	52°15′N.	170°00′W.	66	68.18	31.82	80.6	62–99	49
61	7/17	50°29′N.	170°00′W.	59	57.63	42.37	60.2	40 81	18
62	6/22	55°58′N.	169°59′W.	120	85.00	15.00	100.0	88 -100	100
63	6/24	54°00′N.	169°59′W.	120	65.83	34.17	76.0	62 -90	100
64	6/25	53°20′N.	169°59′W.	117	78.63	21.37	100.0	88–100	100
65	7/21	51°51′N.	169°59′W.	211	64.45	35.55	73.4	63 84	15
66	6/26	52°15′N.	169°57′W.	64	62.50	37.50	69.6	50–89	88
67	7/25	53°05′N.	166°05′W.	33	42.42	57.58	30.9	4–58	76

[1] Lower limit truncated at 0 and upper truncated at 100 percent.

High seas sample locations and summarized results of classificatory analysis are presented in Table 14.

Bering Sea 1960

May and June.—The point estimates of the proportion of the alternative red salmon stocks in all samples taken east of 175°54′E. longitude indicated an overwhelming dominance of Bristol Bay morphotype (Fig. 24). With the exception of samples 25 and 63, all were estimated to contain greater than 85 percent Bristol Bay morphotype. Thirteen of the 15 samples east of 178°17′W. longitude contained greater than 90 percent, with nine of the 13 containing 100 percent Bristol Bay morphotype. Samples 25 and 63 were estimated to be 79 and 76 percent Bristol Bay morphotype respectively.

With the exception of sample 63, the upper 90 percent confidence limits for the point estimates included 100 percent. The upper 90 percent confidence limit for sample 63 was 90 percent. Due to its occurrence among samples for which point estimates were near 100 percent, the failure of the upper confidence limit of sample 63 to include 100 percent is interpreted to be attributable to random variation in sampling Bristol Bay stocks at sea. This does not preclude the possibility, however, of the actual presence of a small percentage of Kamchatkan red salmon or fish from areas other than Kamchatka and Bristol Bay.

West of 175°E. longitude only two samples were obtained. Eight percent of sample 17 which was taken on June 28 at 59°41′N. latitude, 172°42′E. longitude was classified as western Alaskan morphotype. Sample 8 was estimated to contain 42 percent Bristol Bay morphotype.

July and August.—Only one sample (49) was obtained from the Bering Sea in July (Fig. 25). This was taken on July 7 at 53°44′N. latitude, 173°W. longitude and was predominantly mature fish (71 percent).

Bristol Bay morphotype were estimated to compose 74 percent of this sample. No samples were obtained from the Bering Sea in August.

North Pacific Ocean 1960

May and June.—Eighteen samples (Fig. 24) were taken in the North Pacific Ocean during May and June, one containing 88 percent and 11 containing greater than 90 percent maturing salmon. Samples 18, 19, 43, 51 and 55 contained a comparatively high percentage of immatures. Data on maturity were not available for sample 7.

Bristol Bay morphotype dominated the nine samples taken east of 179°59′E. longitude. Six of these nine samples, mostly of mature salmon, were estimated to contain from 59 to 100 percent Bristol Bay morphotype, the lowest percentage occurring in sample 51.

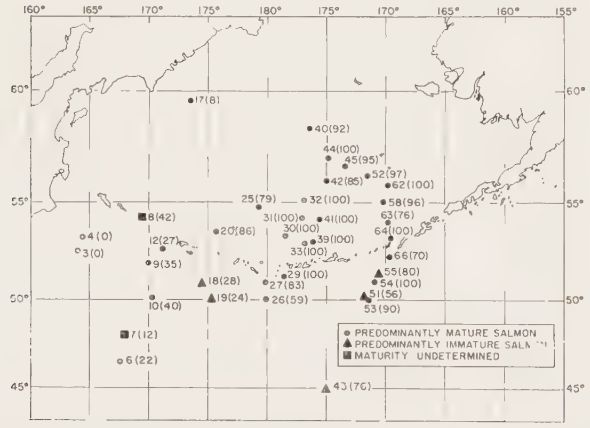

FIGURE 24. Percentage of samples classified western Alaskan type—May and June, 1960. First number indicates sample number; second number percent western Alaskan type.

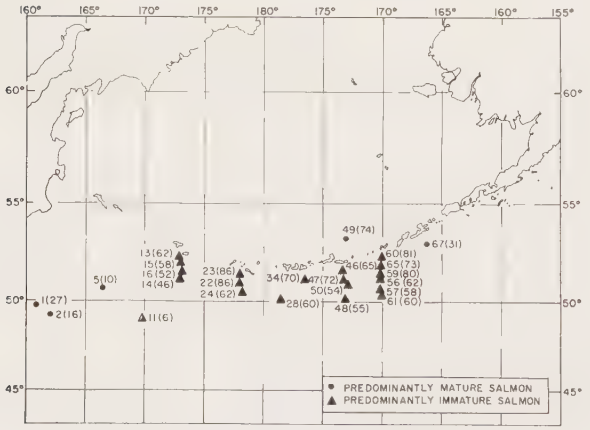

FIGURE 25. Percentage of samples classified western Alaskan type—July, 1960. First number indicates sample number; second number percent western Alaskan type.

West of 175°03′E. longitude, Kamchatkan morphotype were indicated to dominate all nine samples. Kamchatkan morphotype totally dominated samples 3 and 4, and the remaining seven samples contained from 60 to 88 percent Kamchatkan morphotype. Samples 18 and 19 which contained a large proportion of immature salmon were estimated as 28 and 24 percent Bristol Bay morphotype respectively.

July.—Twenty-four samples were taken in July, all north of 49° North latitude (Fig. 25). All samples were composed predominantly of immature salmon with the exception of sample 67 at the eastern extreme and samples 1, 2 and 5 at the western extreme of sampling.

The latter three samples were classified as 27, 17 and 10 percent Bristol Bay morphotype. From time and area of capture, under the tacit assumption of "homing", the mature portion of these samples must have been Kamchatkan salmon. As indicated previously, sample 2 was included in the estimation of the average error of misclassification for Kamchatka, but samples 1 and 5 were not. Sample 1 was small and sample 5 was taken east of 165°E. longitude. The possibility exists that the values obtained were the result of sampling variation, but this cannot be adequately evaluated for lack of repetitive sampling in this region.

Judging from time of sampling (July 25) sample 67 probably fails to satisfy our basic assumption that only Kamchatkan and Bristol Bay salmon occur in the regions under study. The major portion of the runs had entered the streams of Bristol Bay and Kamchatka before this sample was taken. Therefore, this sample is considered to contain red salmon from North American areas other than Bristol Bay which have been shown by past analyses to misclassify in considerable proportion as Kamchatkan red salmon (Fukuhara *et al.*, 1959).

In all but two of the samples composed chiefly of immatures, Bristol Bay morphotype is found in the majority. This predominance tends to be more pronounced in the samples obtained closest to the Aleutian Islands. As in previous years, the marked dominance of either continental stock that is apparent in most samples of matures is not seen in most samples of immatures. This situation may arise as a consequence of improper weighting of the function when applied to immatures. Intermingling of Kamchatkan and Bristol Bay immatures may occur, or Bristol Bay stocks may be intermingled with red salmon from other North American areas.

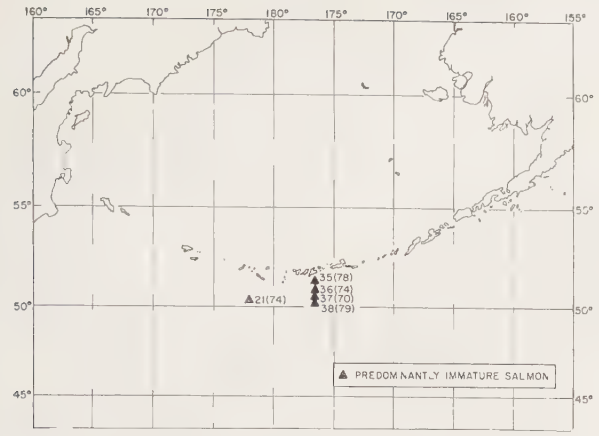

FIGURE 26. Percentage of samples classified western Alaskan type -August, 1960. First number indicates sample number; second number percent western Alaskan type.

August.—Only five samples were utilized from the August collection, all of which were obtained in the central Aleutian region with four of these taken in a rather narrow band along 176°30′W. longitude (see Fig. 26). The point estimates of Bristol Bay morphotype in these samples ranged from 70 to 79 percent.

SUMMARY AND CONCLUSIONS OF CLASSIFICATION ANALYSIS

1. The 1960 high seas samples were classified as being of Kamchatkan or Bristol Bay origin using the discriminant function constructed on the basis of the 1956 collections but with the average error of misclassification of Bristol Bay salmon weighted by the relative abundance of the component stocks based on the 1960 escapement estimates.

2. In the light of a very large run of red salmon to Bristol Bay, it was expected that large areas in the ocean, particularly the Bering Sea east of 180° longitude, would be almost completely dominated by mature Bristol Bay red salmon. In agreement with this expectation, all samples taken east of 180° longitude showed an overwhelming dominance of Bristol Bay morphotype (average point estimate greater than 90 percent) with the upper 90 percent confidence limit averaging about 104 percent and the lower limit averaging about 79 percent.

3. In the North Pacific Ocean in May and June (Fig. 24) mature Bristol Bay red salmon predominated east of 179°59′E. longitude by percentages ranging from 59 to 100 percent. West of 172° E. longitude Kamchatkan red salmon predominated by percentages ranging from 60 to 100 percent in samples of mainly mature salmon.

4. The general trends in the east-west distribution of Kamchatkan and Bristol Bay stocks in both the Bering Sea and North Pacific Ocean are similar for the years 1956 through 1960. To illustrate this the average percentages of western Alaska morphotype in samples taken in the high seas in May and June of 1956 through 1960 are plotted in Figure 27 in five degree intervals of longitude.

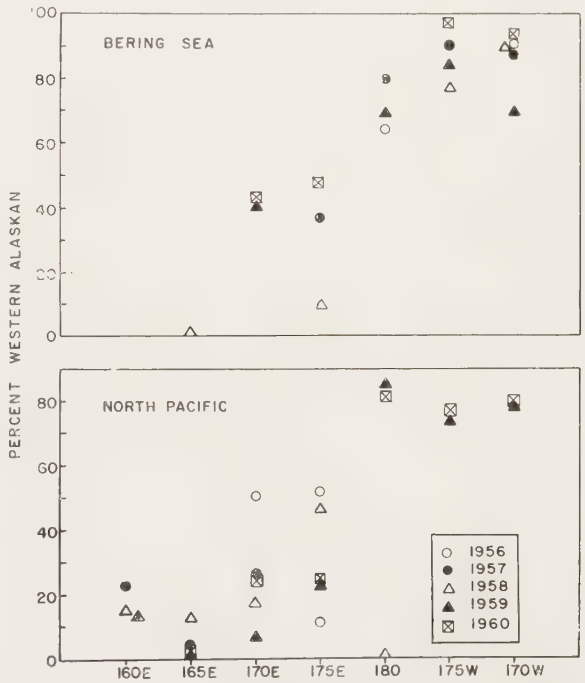

FIGURE 27. Average percentages of western Alaska morphotype in samples taken in the Bering Sea and North Pacific Ocean in late May and June, 1956-1960.

5. Bristol Bay morphotype dominated all samples of immatures to 172°50′E. longitude in July and August. As in past years, the degree to which Bristol Bay red salmon dominate is not as pronounced in immature samples as in samples dominated by matures. This may be attributable to the fact that when sampling takes place, the matures could be more segregated during migration. A further possible explanation may be that given in item 6.

6. It was assumed in this (and previous classification analyses) that only Bristol Bay and Kamchatkan red salmon occur in the Bering Sea and North Pacific Ocean west of the Alaskan Peninsula. This assumption has been tenably justified for maturing salmon but not for immatures. Although there has been little evidence to negate the hypothesis for

immatures, there is a distinct possibility that red salmon from North American areas other than Bristol Bay may occur in the area. Past analyses have shown that using this particular discriminant function, these would be misclassified as Kamchatkan salmon. Alternative analyses must be used to provide information on the origin of these immature stocks prior to interpreting results of immature classification using discriminant function analysis.

7. Deficiencies in sampling are evident in the scarcity of samples from the western Bering Sea and in May and June from the North Pacific Ocean, limiting present knowledge of the distribution in the high seas of Kamchatkan and western Alaskan stocks of red salmon. Although samples containing a predominance of matures taken after certain times can be reasonably used as the Kamchatkan reference morphotypes, the desirability of having stream samples is obvious.

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RED SALMON SCALE STUDIES

by Raymond E. Anas

Red or sockeye salmon are widely distributed in the northern Pacific Ocean. Tagging, parasitological and morphological studies have shown that maturing fish from Asia and North America intermingle in the area north and south of the Aleutian Islands and that the North American red salmon in this area are predominantly from Bristol Bay. The problem to be solved by fishery scientists is to determine the continent of origin of salmon caught on the high seas with a known precision.

Scale studies are one technique that has been used for identifying the continent of origin of salmon taken at sea. Advantages of using scales are that they are relatively inexpensive to collect and process. Various methods employing scales have been developed and show promise of distinguishing Asian from Bristol Bay red salmon. However, the application of scale characters has been questioned owing to inadequate studies, in most cases, of factors that could affect the precision and reliability of continental separation. We have studied some of the factors that could affect precision, and the results of these studies are summarized in this report.

Adequate samples are needed to determine scale character values that are representative of specific areas. For example, a sample from a Bristol Bay river could be taken and scale character values could be compared for fish having different ages. If scale character values change depending on the age of the fish, and if this affects its classification as Asian or from Bristol Bay, then fish of each age must be considered separately. As a consequence, larger samples would be required to determine scale character values representative of Asian and Bristol Bay fish, because each age group would need its own estimate. Fish caught at sea would also need to be considered by age group; the sampling problem for these is even more difficult than for the inshore samples.

Scales have ridges or circuli on their surface that are used by biologists to determine how long a fish has lived and also to determine where it was hatched. The spacing of the circuli is used to determine the age; the spacing of circuli, number of circuli, scale length, and ratios using circuli counts and scale lengths are used to determine the continent of origin. Structurally, salmon scales begin as a small central

plate and the circuli form concentrically around this plate as the scale grows. Since the central plate is common to all scales, it can be used as a starting point to determine scale characters and factors that could affect scale character values.

Using the central plate as a focus, radii can be drawn at different angles across a scale and scale character determinations can be made on lines at these angles. The question arises, however—are scale character values different depending on the scale angle that is used? If scale character values do change when determined at different angles, and if this affects assignment to continent of origin, then the scale angle used to determine scale character values should be consistent. The first step in testing scale angles is to see if a consistent axis of the scale can be chosen. This is important because the precision of selecting any particular angle of the scale must be known before the data can be considered reliable. It was determined that the freshwater axis (which was chosen by visually dividing the freshwater zone of the scale into two equal parts and using the mid-line as the axis) could be selected with a precision that did not introduce significant error in the scale character values. Therefore, the freshwater axis was used to establish the selected scale angle. It was found that scale character values differ greatly for a single scale when these values are taken along different radii. Therefore it is necessary to establish precisely the angle of examination.

Red salmon ages are determined visually by personnel trained to interpret the spacing of the circuli of the scale. The accuracy of ages derived from scale reading cannot be known without supplementary information such as tagging or marking experiments, but a test of the consistency of age determinations is possible. Scales from 180 red salmon were examined by three trained personnel separately and age determinations made. A conference was held by the same three persons to derive an "agreed" age for all scales. Using the "agreed" ages, the average error in age determination was 13 percent per reader. This difference did not affect circuli counts or measurements of the total freshwater or first ocean zones.

Scales taken from different body locations might vary in scale character values and in apparent age because they are not all formed at the same time. To test this possible source of variation, a fish from the Naknek River was selected. From a chosen scale (as in Figure 28) it was determined that this fish had migrated seaward in the third year of life and returned to spawn in the sixth year. Some scales taken in

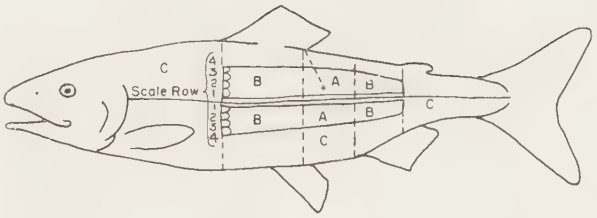

FIGURE 28. Scale sampling code used by agencies of the INPFC. A* is the preferred scale.
A—preferred area if preferred scale is missing.
B—second choice if scales in area "A" are missing.
C—all other scales.
Scales may be taken from either side of the fish, but left side is preferred. (From Proceedings of the 1957 Annual Meeting, INPFC, p. 73.)

body area C (Figure 28) above the anal fin and by the pectoral fin indicated the fish had migrated seaward in the second year and returned to spawn in the fifth year. This suggests that all scales from the same fish do not give the same age reading and that body-zone-C scales taken below the lateral line are questionable for age determinations. Area A and area B scales were tested for the scale characters, and it was found that only area A scales should be used. Consequently we have used only body-zone-A scales for determining scale characters.

Because mature males are usually larger than mature females of the same age, it was considered possible that the variation in body size might be reflected in the scale. However, tests of scale characters showed no difference between males and females for circuli counts and measurements of the first and second year freshwater zones, the total freshwater zone and the first year in the ocean zone. Ratios of circuli counts of these zones were not different between males and females. Characters computed from the ratio of freshwater zone radius to the radius of the scale (after one and two years at sea) were different between sexes.

Intra-seasonal differences were tested by using samples collected on different dates from individual Bristol Bay streams. No differences were found for any of the scale characters. Marked differences have been noted in the scale patterns of red salmon which were taken from different parts of the run of rivers other than those of Bristol Bay.

Individual red salmon spend different amounts of time in fresh water before migrating seaward. When scale samples were separated according to the number of years spent in fresh water and the presence or absence of rapid growth just prior to seaward migra-

tion, the numbers of circuli and width of the zones were found to differ for the freshwater portions of the scales. However, the width of the zone which was deposited during the first year at sea was found to be free from this difficulty. Fish with different freshwater ages should be considered separately for all other scale characters because the scale character values are significantly different depending on the freshwater age. Such groups can not be combined. This required that separate systems be developed for each group if freshwater zones of the scales are to be used to identify the origins of fish taken at sea.

From one to four years are spent at sea, with most of the maturing fish having either two or three zones on their scales (each zone represents one year of ocean residence). Tests of this source of variation show that only the width of the total freshwater zone can be used to determine the origins of high seas samples containing fish of different ocean ages. To use other characters, the samples should first be separated according to the number of years spent at sea.

If a single discriminant is to be appropriate for identifying the origin of salmon found at sea, the scale characters used must be constant for successive brood years. Fish of different brood years are mixed both at sea and in the spawning runs, so this source of variation cannot be ignored. No scale characters were suitable for combining brood years.

The following can be concluded from these scale studies:

1. The average error in determining the ages of 180 red salmon by three trained personnel was 13 percent per reader. This difference did not affect the accuracy of circuli counts and measurements of scale width.

2. A scale axis can be selected with an average deviation of plus or minus two degrees and a maximum expected deviation of plus or minus ten degrees. No bias is introduced by this amount of variation.

3. It is important to always use the same scale axis to measure and count scale characters. Deviations could cause error in determining the origin of fish taken at sea.

4. The body zone from which a scale is taken is important. Some scales taken from body area C below the lateral line are questionable for determining ages. Scales from body area A are acceptable for determining scale characters.

5. Sampling dates can be ignored as a source of variation for Bristol Bay rivers.

6. No difference was found between scales from male and female fish in measurements or circuli counts in the freshwater zone, or in the part of the scale reflecting the first year of sea life. Data for males and females can be combined for these scale characters.

7. The circulus count and scale width of the first ocean zone was found to be free of differences arising from variations in freshwater age and growth patterns.

8. Only the total freshwater scale length is free from variations connected with differing ocean ages.

9. Brood year differences occur for all scale characters, and brood years are a definite source of variation.

PINK SALMON STUDIES

by Roger E. Pearson

Three morphological characters were obtained from salmon collected in 1957 and used for a preliminary study to examine their utility in separating Asian from North American pink salmon in offshore samples. Results were reported in Amos *et al.* (1960). It was found that North American pink salmon from spawning areas south of Kodiak Island and Cook Inlet were distinguishable from pink salmon of the major Asian spawning areas. The characters could not separate pink salmon of the Alaska Peninsula, Aleutian Islands and northwestern Alaska from those of Kamchatka. Since it is probable that these North American fish are present in the high seas samples, additional research to obtain their separation was initiated. This research was directed toward two goals: the first was to examine a set of new scale characters to determine their suitability for use in the separation analysis of 1959 samples, the second was to classify correctly all 1959 North American inshore samples to their natal continent and identify the origins of the fish in the 1959 high seas samples.

Suitability of Scale Characters for Use in the Separation Analysis

Before a scale character based on a circuli count or measurement can be used to determine the continent of origin of pink salmon, several important questions must be answered. A determination must be made as to whether the scale reader can accurately repeat his count or measurement. Do scales from different positions on the body of the fish show the same characters? Are the scale characters the same on male and female fish? Are the scale characters influenced by the length of the fish? The following results were obtained from testing these possible sources of variation:

1. *Ability of a scale reader to repeat his count or measurement.* Thirteen scale characters were tested to discover if a scale reader could accurately repeat a previous circuli count or measurement. One character was dropped from the study for lack of accuracy. The remaining 12 were satisfactory.

2. *Differences in counts and measurements of scales from different body positions.* Scales from various body positions were examined to determine if the mean values of their characters were similar. If the counts or measurements differ, scales from only one part of the fish can be used in the separation analysis. The results indicated all circuli counts follow a pattern similar to that shown in Figure 29 where higher mean values occur in the posterior body positions. Because of these differences, only scales from one part of the fish were used in this study.

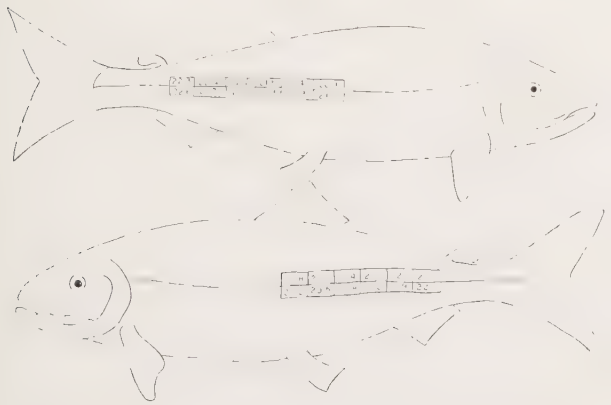

Figure 29. Total circuli count in the first year of scales from different body positions. Right and left sides.

3. *Sexual differences in circuli counts and measurements.* Each character was tested to determine if differences occurred between sexes. If no difference was found, the sexes were combined in the samples. If the sexes differed, the character was dropped from the study or retained when differences were considered negligible. Two characters were dropped from the study when they were found to differ between sexes.

4. *Effect of fish length on circuli counts and measurements.* It is not always possible to collect fish with length typical of their race, because certain types and sizes of fishing gear will select fish by length. If the characters being studied are influenced by length, biased samples will occur when specimens of non-representative size are collected. To examine this possibility, tests were performed to determine the relationship between fish length and each of the characters. The results of these tests indicated length of fish had a negligible effect on the circuli counts and measurements.

Thus three of the original 13 scale characters were judged unsuitable and dropped from the study at this point. The remaining ten were judged on their ability to separate North American inshore samples from Asian samples. Four of these ten characters were found to be excellent separators, and these four characters plus two from the previous study were used in separating the 1959 high seas pink salmon samples. The scale characters were taken from the first year's growth zone and are: (1) number of circuli in the first half, (2) number of circuli in the second half, (3) the number of circuli in the second 1/6, and (4) width of the narrowest band of three successive circuli in the first ten circuli. The meristic characters were the number of vertebrae and the number of branchiostegal rays.

Classification of 1959 Samples to Continent of Origin

Inshore samples from the Alaska Peninsula, Aleutian Islands and Northwestern Alaska could not be distinguished from Asian fish in the 1957 collections; consequently, if any specimens from these areas were present in the offshore samples, they would have been erroneously classified as Asian. The purpose for choosing the six discriminating characters mentioned in the previous paragraph was to correct this error in classification.

Pink salmon caught on the high seas in 1959 were classified as to continent of origin using a discriminant function analysis. Offshore samples from the east coast of the Kamchatka Peninsula were selected as an Asian standard. The selection of eastern Kamchatka was based on the results of fish tagging ex-

periments, on the large size of coastal Kamchatka catches, and proximity of Kamchatka to the locations of the high seas sampling areas. Five inshore samples from western Alaska were selected for the North American standard. These samples were from areas close to the high seas sampling locations.

Table 15. Results of 1959 pink salmon classification to continent of origin.

Sampling date	Location of sample	Sample size	Percent classified: North American type	Percent classified: Asian type
North American inshore samples				
9/1	Fraser River (British Columbia)	45	100.0	0.0
8/14	Rivers Inlet (British Columbia)	52	100.0	0.0
8/14	Skeena River (British Columbia)	56	100.0	0.0
8/16	Ketchikan (Southeastern Alaska)	26	100.0	0.0
8/18	Ketchikan (Southeastern Alaska)	24	100.0	0.0
8/3	Petersburg (Southeastern Alaska)	47	100.0	0.0
8/9	Petersburg (Southeastern Alaska)	20	100.0	0.0
8/6	Uyak Bay (Kodiak Island)	60	93.3	6.7
7/30	Ivanof Bay (Alaska Peninsula)	63	95.2	4.8
8/1	Coal Bay (Alaska Peninsula)	66	72.7	27.3
8/13	Hook Bay (Alaska Peninsula)	47	80.9	19.1
7/10	Unalakleet (Northwestern Alaska)	60	86.7	13.3
High seas samples				
7/26	53°55N. 159°40W.	50	96.0	4.0
7/25	53°00N. 160°00W.	38	94.7	5.3
7/5	51°00N. 169°56W.	52	15.4	84.6
7/4	52°00N. 169°53W.	43	20.9	79.1
7/2	53°58N. 170°01W.	23	8.7	91.3
7/3	53°18N. 170°00W.	54	9.3	90.7
6/27	59°00N. 170°00W.	42	59.5	40.5
6/21	52°59N. 175°00W.	64	10.9	89.1
6/24	56°00N. 176°00W.	69	15.9	84.1
6/23	55°00N. 176°00W.	53	9.4	90.6
6/22	54°00N. 176°00W.	49	18.4	81.6
6/15	51°31N. 176°25W.	41	14.6	85.4
7/27	51°31N. 176°42W.	26	65.4	34.6
6/14	51°23N. 176°45W.	32	9.4	90.6
6/22	52°38N. 178°47W.	40	12.5	87.5
6/30	60°00N. 180°	64	12.5	87.5
6/28	58°00N. 180°	60	15.0	85.0
6/27	57°00N. 180°	44	38.6	61.4
6/26	56°00N. 180°	20	10.0	90.0
6/25	55°00N. 180°	63	14.3	85.7
6/24	54°00N. 180°	86	16.3	83.7
6/13	53°30N. 180°	23	0.0	100.0
6/23	52°59N. 179°55E.	48	14.6	85.4
7/4	58°00N. 175°00E.	70	20.0	80.0
5/25	48°00N. 175°00E.	45	22.2	77.8
7/15	55°00N. 175°00E.	84	13.1	86.9
7/5	56°49N. 173°22E.	52	13.5	86.5
5/26	48°57N. 169°29E.	23	17.4	82.6
7/15	48°48N. 168°36E.	22	18.2	81.8
7/5	52°32N. 163°48E.	34	8.8	91.2
6/15	48°31N. 162°31E.	23	17.4	82.6
5/30	44°54N. 161°03E.	22	4.5	95.5
7/10	47°20N. 155°53E.	53	22.6	77.4
6/30	45°24N. 152°58E.	33	33.3	66.7
6/14	43°48N. 150°27E.	42	28.6	71.4

Individual fish from the inshore and high seas samples were classified into either of the two continental groups. Sample locations and results of classification are found in Table 15. All North American inshore samples were correctly classified into their continental group. Samples from the Alaska Peninsula and Northwestern Alaska were found to be distinguishable from the Asian standard. Individuals in the high seas samples were most frequently classified as Asian. However, three samples obtained on the North Pacific in the latter part of July were predominantly of North American type fish (Figure 30). One other sample obtained from the eastern Bering Sea on June 27 was classified as chiefly North American.

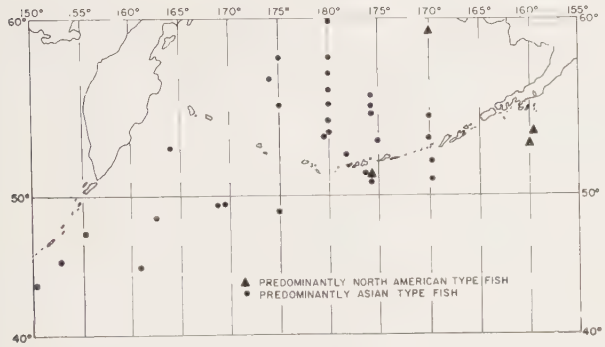

FIGURE 30. Classification of 1959 high seas samples of pink salmon into continental groups.

SUMMARY AND CONCLUSIONS

Morphological and scale differences between fish are being examined as a possible method of separating Asian from North American pink salmon in high seas samples. A preliminary study with the 1957 collections indicated additional characters were needed to distinguish fish of the Alaska Peninsula, Aleutian Islands and Northwestern Alaska from those of Asia. As a result, four new characters were added to the separation analysis after appropriate testing. The new characters were used with two from the previous study to classify the 1959 collections to continent of origin. In the 1959 collections, all North American inshore samples were distinguishable from Asian samples. However, only four high seas samples resembled North American type fish. The majority of samples were classified as Asian.

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CHUM SALMON STUDIES

by John LaLanne

The principal objective of this study has been to identify the continental origin of chum salmon taken at sea. A large number of chum salmon morphological characters (structures and body form) have been examined for possible consistent differences between Asian and North American chum salmon. The most useful characters have been the number of vertebral segments, the number of fin ray elements, and other segmented bony structures which have shown differences between populations of Asian and North American chum salmon.

We have applied these characters in a method which enables us to identify the continental origin of chums taken at sea with the exception of those from rivers entering the Bering Sea, and rivers of the Kodiak Island region. Because these rivers most likely contribute significant numbers of chums to the high seas area under study, we have begun examination of scale structures for possible differences between chums from these regions.

Chum salmon scales are flat calcified structures, generally round or oval in shape. Near the center is a platelet or focus. Circular or semicircular ridges (circuli) concentric to the focus occur on the anterior portion of the scale (Fig. 31). When scale growth is rapid, thick widely spaced circuli are formed; when growth is slow, narrow closely spaced circuli are formed. Since protracted slow growth usually occurs once annually in the winter, the band of narrow closely spaced circuli formed is called an annulus and is used in determining the age of the fish. Counts of the number of circuli and scale length measurements are the scale characters most commonly used to identify the origin of the fish.

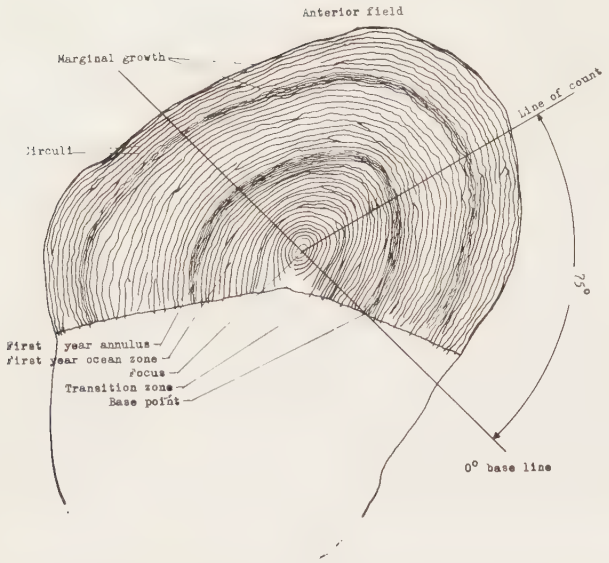

FIGURE 31. Diagram of chum salmon canted right scale with descriptive notations.

As a prerequisite to using scale characters for differentiating Asian and North American chums, it is necessary to evaluate the effect on the characters of such extraneous factors as differences in scale shape, the location on the fish's body from which scales are sampled, the area studied on the scale, the sex or age of the fish, and others. It is possible that supposed differences between chums from the two continents could be due only to these factors.

For example, if the number of circuli is different for scales sampled near the head of the fish and those sampled near the tail, then all scales must be taken from one or the other location. Otherwise, differences in number of circuli between Asian and North American chums would occur simply because North American chum scales were sampled, say, near the head and Asian scales near the tail.

Also, it is important to know the age of the fish so that the different age groups can be compared. The annual marks on scales have been used to determine the age of many species of fishes. Only limited study has been made of the scale method of age determination of chum salmon.

In 1961, chum salmon morphological research was directed toward evaluating the effect of extraneous factors on scale characteristics, developing methods of producing consistent and comparable scale data, and examining the validity of using scales for age determination.

Effect of Extraneous Factors on Scale Characteristics

Scale shape. It was found that with the exception of a few randomly distributed intermediate type scales, the scales on a chum salmon are of two general shapes, canted left and canted right (Fig. 31). The spacing and number of circuli change with scale shape. If a fixed line of count or measurement was established for all scales then a spurious difference between Asian and North American chums could result from more canted left scales being sampled from Asian chums than North American chums. Therefore scale shape must be considered when counting circuli or measuring scale lengths. The line of count or measurement should change with the scale shape.

Line of count and measurement. In an attempt to obtain consistent results, chum salmon scale counts and measurements have usually been made along or within certain limits on either side of the longest axis of the scale. The longest axis is generally established as the longest radius from the center of the focus to the periphery of the anterior portion of the scale or the edge of a particular annulus.

A comparison was made between the longest axis method of establishing the line of count and other methods. A base line on the scale from which a line of count can be projected was found to provide a more consistent line of count than the longest axis method (Table 16). The base line is defined as a line from the center of the focus to a base point where the first annulus enters the transition zone between the anterior and posterior portions of the scale (Fig. 31). There are two base points, one where the annulus enters the transition zone on the left and one on the right. The base point closest to the focus is used. The use of the closest base point accounts for scale shape. The closest base point is on the right for canted right scales and on the left for canted left scales.

TABLE 16. Comparison of angular variation within line of count by " base line " and " longest axis " methods. For each scale two determinations were made by each method.

Method	*N*	Min. diff. (degrees)	Max. diff. (degrees)	*S D*	Mean diff.
Base line	22	0.0	8.5	1.95	1.4
Longest axis	22	0.0	37.5	9.50	5.0

The closest base point is determined by measurement. The base line is established on the right side of the scale for the few scales having equally distant base points.

Effect of change in line of count. Having determined a consistent method of establishing the line of count, the variation of scale characters with change in line of count was examined.

Total circuli counts and scale length measurements of the first year zone (Fig. 31) were made at 15 degree intervals. The mean number of circuli and the mean total length of the first year zone clearly differ with change in the position of the line of count for both scale shapes (Figs. 32 and 33). It is evident that circuli counts and scale length measurements must be made along a particular line for consistency of results. A radial line at an angle of 75 degrees from the base line for both canted right and canted left scales was chosen for the following reasons:

1. For the areas and scale shapes sampled, these radial lines are at a position on the scale where the highest average number of circuli are formed over the greatest average length.

2. Irregular, broken and discontinuous circuli are not as frequent in the proximity of these radial lines as on other areas of the scale.

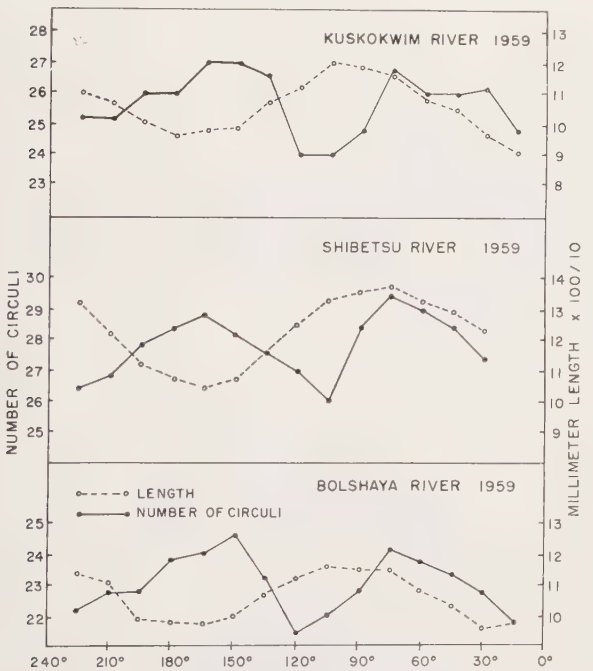

FIGURE 32. Variation in mean number of circuli and mean length of first year zone of canted right chum salmon scales with change in position of angle of count. Five scales in each sample.

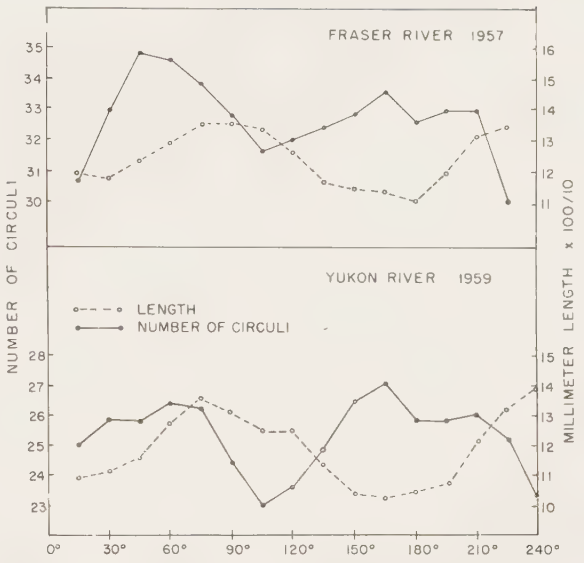

FIGURE 33. Variation in mean number of circuli and mean length of first year zone of canted left chum salmon scales with change in position of angle of count. Five scales in each sample.

Effect of scale regeneration. When a scale is lost from a chum salmon a new scale very quickly replaces the lost scale. The replaced or regenerated scale tends to have a scar-like appearance and few if any normal circuli. As the fish continues to grow, the scale resumes normal growth and it is generally assumed the replaced area maintains its scar-like appearance. Scales having regeneration scars in the area of study are discarded.

It was observed that the size and shape of the center or focus of chum salmon scales varies considerably and often is scar-like in appearance. This occurs not only on scales from different fish but also on scales closely approximated on the same fish. Possibly some scales having what has been considered a large "normal" appearing focus may actually be scales with regenerated centers. The very small scales on fingerling chum salmon 4–6 cm. in length generally have formed approximately from one to four circuli. It is possible that the scar left by scale replacement at the fingerling stage cannot in many cases be recognized on scales of older fish. This could be a serious source of error in studies using circuli counts because population differences could be obtained that were due only to the presence of undetected regenerated centers.

In lieu of further study, the circuli counts made

in the first one-eighth of the length from the center of the focus to the outer edge of the first annulus will be recorded and analyzed in a manner so that their possible exclusion at a later date will not affect the analyses of other counts. The first one-eighth was arbitrarily chosen as that region at the center of the scale where the occurrence of regeneration would be most difficult to detect and because " large foci " were included in this region.

Variation of circuli counts with body position. Since all scales usually do not form on the body of fish at the same time, there is usually a difference in circuli counts with change in sampling location on the body.

Scales sampled from various body locations on a single chum salmon specimen caught in the Kuskokwim River on July 2, 1958, were examined in a preliminary attempt to determine the variation in first year circuli counts with change in body position of scales.

We were especially interested in the variation within the A and B sampling area (Fig. 28) on both the left and right side of the fish. The majority of chum salmon scales used in INPFC studies are sampled from these areas.

Body areas of four scales in a vertical row by ten scales in a horizontal row containing approximately 40 scales were randomly sampled. Ten scales were sampled from each body area included in the A and B body area and five were sampled from all others.

When collecting these data a reading technique, which has been discontinued, resulted in larger than normal reader error. Differences in mean first year circuli counts of 0.5 circuli between any two body areas could be due to reader error. The differences in most cases exceed reader error and the data are satisfactory for the purpose intended.

There is considerable variation in mean first year circuli counts with change in scale location on the body (Fig. 34). There is an indication that scales from the A and B body areas both right and left side may be considered similar in first year circuli counts. Scales outside these locations have been given the general classification of C scales under INPFC scale sampling procedures (Fig. 28). Most of the C scales are lower in mean first year circuli count than A and B body area scales. Since a C scale is not recorded as being sampled from a particular location within the C body area, all C scales almost certainly will have to be rejected as being significantly different from A and B body area scales if first year in ocean circuli counts are used as population indices.

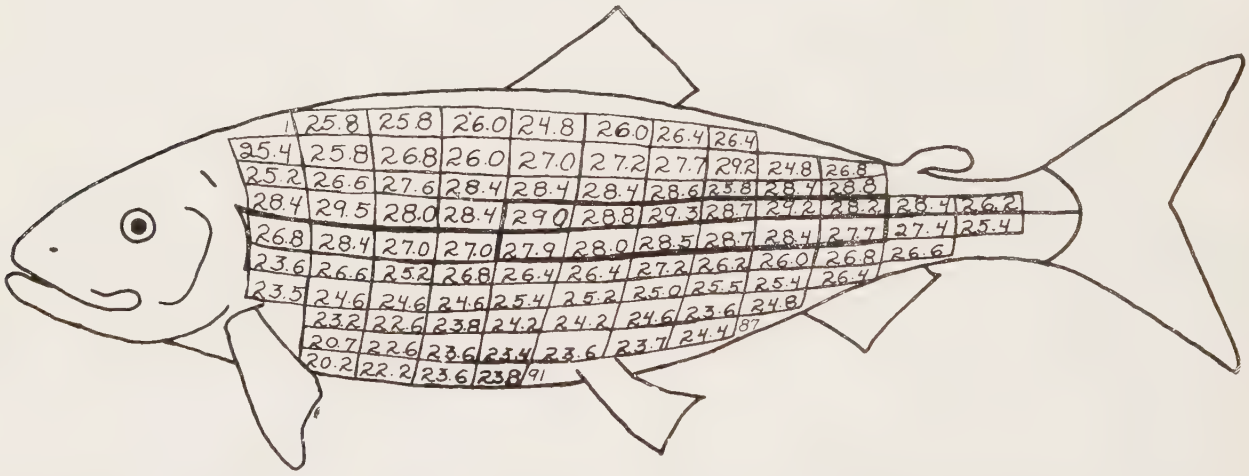

FIGURE 34. Mean number of circuli in first year zone of chum scales sampled from different body areas, left side. Heavy line encloses A and B area.

Additional study of the scale body area problem using different techniques and more specimens from several areas is planned.

Variation due to plastic impression method of duplicating scales. Plastic impressions of the original scale are generally used in most scale studies. There can be variation in the quality of these impressions.

The possibility that circuli counts and scale lengths are affected by variation in the quality of the plastic impressions is being studied.

Age Determination from Chum Salmon Scales

Assumptions

The soundness of the method of using chum salmon scales for age determinations depends on the validity of the following basic assumptions:

1. Recognizable markings occur on the scale annually.
2. The annulus is formed during a particular period of time common to the species or the time of annulus formation is known for the individual specimens.
3. The position on the fish from which the scale is sampled has no effect on age determination.
4. Errors in age determinations made from scales showing signs of absorption (loss of scale material) at the scale margin are negligible.

Annulus and age of fish. The assumption that there are recognizable age marks or annuli present on the scales of chum salmon has been subjected to only limited critical examination.

Absolute proof of the validity of the assumption can be obtained from scales of authentic marked fish of known age. For example, the scale of a chum salmon marked as a young fry and recovered after spending three winters at sea should have three recognizable annuli present. In a preliminary attempt to test the assumption, 96 scales from known age chum salmon were examined by two experienced chum salmon scale readers. The scales were generously provided by the Washington State Department of Fisheries and the Fisheries Research Board of Canada. All scales were sampled from chums that were fin marked as wild fry and recovered as adults.

In most cases the known age of the chum salmon and the age as determined from the scales was the same. Reader 1 rejected eight of the 96 scales because of regeneration scars. Of the 88 scales read by reader 1, only one was aged incorrectly. Reader 2 rejected 15 scales because of regeneration and excessive absorption. Reader 2 incorrectly aged three of the 81 scales he deemed acceptable for age determination.

Scales from other areas and years may be more or less difficult to interpret and other scales from marked chum salmon should be examined. Nevertheless, this test gives strong support to the assumption that there are recognizable age marks (annuli) on chum salmon scales.

Time of annulus formation. It has generally been assumed that an annulus or band of narrow closely spaced circuli is formed on a chum scale in the winter due to a period of slow growth or complete cessation of growth. With the approach of spring it was assumed that new growth occurs and varying numbers of thick, widely-spaced circuli should be formed beyond the annulus by spring. The growth that occurs by spring should be somewhat less than the total growth that occurs for the entire growing season which is assumed to be from early spring to late fall. However, scale examiners have observed scales from chum salmon caught on the high seas in May that have a very large amount of growth at the edge of the scale. This presents a problem when attempting to determine the age of the fish from the scale. Is this large amount of growth "too much" to have occurred by May? If so, then it must be assumed that the growth at the edge of the scale is of the previous year and the annulus must not have formed as yet. If the examiner feels this is true he must add one year (one annulus) to the observed number. At present there is no scientifically established criteria for determining whether this growth is "too much" and errors of one year can occur when determining the age of high seas chums caught early in the year. Knowledge of the time or variation in time of annulus formation would aid in reducing this source of error. Attempts are being made to obtain scales sampled through the year and other data on scale growth are being assembled to obtain further information regarding this problem.

Scale body position and age determination. Generally an attempt is made to sample scales from a particular location on the body of the chum salmon for age determination. However, in many cases scales are missing or unreadable scales are found at the designated location and scales must be sampled from other body positions.

It is possible that all of the scales on a chum salmon are not formed early in life or there may be variation in scale growth such that all scales do not depict the same age. It is therefore important to test the validity of the assumption that all scales on a chum salmon depict the same age.

A random sample of 610 scales was taken from a single chum salmon specimen. The scales were randomly intermixed with other chum scales to eliminate bias when determining the age. All

readable scales examined depicted the same age. However, on the basis of evidence from one fish only limited conclusions regarding this problem can be made. A more extensive study into this problem is planned using more specimens.

Absorption and age determinations. The majority of the scales sampled from chum salmon caught in streams and estuaries show evidence of absorption (loss of scale material) at the margin of the scale. When these scales are used to determine the age of the fish the reader must attempt to estimate the amount of absorption that has occurred. This estimate is generally based on the degree to which the margin of the scale differs in appearance from the normal. In other words, has the loss of scale material from the edge of the scale been great enough to remove one or more annuli? Generally no scientifically established method of measuring absorption is available.

It appears that errors of one or more years can be made when using partially absorbed scales for age determination. Further study of the effect of scale absorption on age determinations and of the possibility of using otoliths and other methods to supplement current procedures is in progress.

Summary

Differences in meristic characters have enabled us to identify the continental origin of chums taken at sea with the exception of those originating from the Bering Sea coast and Kodiak Island region. Scale characteristics are being examined for possible differences which can be used to supplement meristic characters.

This report places particular emphasis on the methods and assumptions required in the use of chum salmon scale characteristics for population differentiation and age determination studies.

A method of establishing a line of count and measurement that is consistent and also accounts for scale shape is described. Circuli counts and scale lengths differ with change in position of line of count or measurement on the scale.

Regeneration of scales may be difficult to detect in some cases, especially in the central area of the scale. Variation of scale characteristics with change in scale sampling area on the body is of sufficient magnitude to be a serious source of error in a study designed to separate Asian and North American chum salmon. The quality of the plastic scale impressions may affect the validity of scale racial data. Proof of the validity of age determinations made from chum salmon scales is given by agreement of scale age determinations with the known age of marked fish. Lack of knowledge of the time of annulus formation can result in errors of unknown magnitude in age determinations of chum salmon, especially those taken early in the season.

Age readings of 610 scales sampled from a single chum salmon specimen gave limited evidence supporting the assumption that all readable scales on chum salmon have the same number of annuli regardless of body position of the scale.

Age reading of partially absorbed scales are subject to errors of unknown magnitude. Studies designed to solve these problems are in progress.

KING CRAB STUDIES

by Herbert Shippen and Takashi Miyahara

The year 1961 saw continuation of rapidly increasing fishing pressures on eastern Bering Sea king crabs. In 1960 one Russian and two Japanese motherships were operated; in 1961 two Russian and five Japanese motherships took part in the fishery.

By utilizing available catch statistics and announced production targets, we can estimate the catch of Japanese king crab operations in the eastern Bering Sea in 1961 to be about 3.5 million male crabs. For the two Russian mothership expeditions we can only guess that a combined total of about two million crabs may have been taken. The estimated 5.5 million crabs removed by these two nations is probably conservative and represents at least a fourfold increase in the catch of king crab in the eastern Bering Sea in comparison with the level of fishing during the period from 1953 to 1958 (Fig. 35).

In addition to expansion of king crab fishing by Japan and Russia, there have also been increases in groundfish operations. Although these fleets are

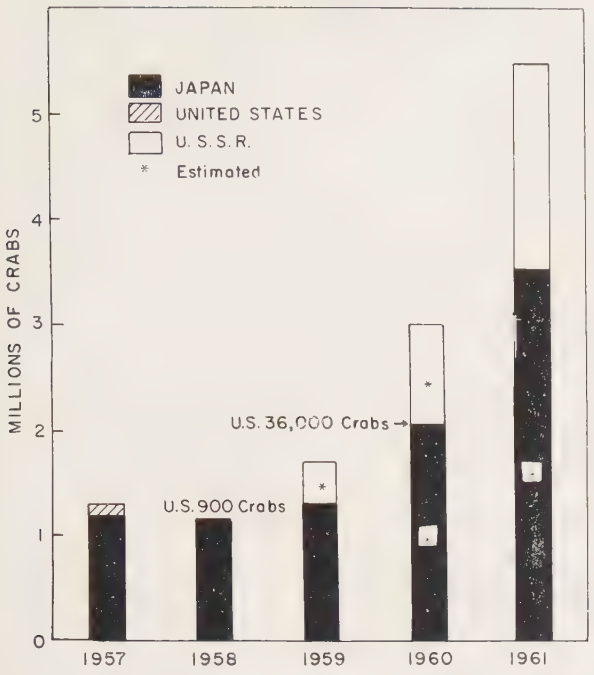

FIGURE 35. Commercial catch of adult male king crabs in eastern Bering Sea, 1957–1961.

primarily harvesting fish, we expect that substantial numbers of king crabs are also taken. Requests for catch data of all fishing operations in this area have been made to the governments of Japan and the Soviet Union.

United States' king crab research activities in the eastern Bering Sea were conducted from the 80-foot research trawler *Paragon* during July. The vessel was chartered by the Bureau of Commerical Fisheries, and after initially being used in salmon studies, spent four weeks in the Bering Sea sampling king crabs. Sixty stations were successfully completed where 3,775 male and 1,608 female crabs were sampled and measured; 2,790 male crabs were tagged and released —twice as many as we were able to tag last year.

In addition to tagging for growth, migration and mortality studies, meat content, ecological and oceanographic data were collected. Two research objectives which we had hoped to achieve during the 1961 charter period were, however, only partially completed due to the lack of vessel charter time. One of these objectives was to define the extent of distribution of adult male king crabs in the eastern Bering Sea by means of systematic sampling on the 20-mile grid pattern which we have used in past years. In order to obtain reliable estimates of population abundance and to insure random distribution of tagged crabs throughout the populations, it was necessary that the station pattern be extended sufficiently to include the area occupied by the stock. Preliminary examination of the 1961 station pattern catches indicates that crabs were probably distributed well beyond the area surveyed.

A second phase in which we fell short of the measure of success for which we had hoped was in the release of double-tagged crabs. The purpose of this experiment was to ascertain the rate at which tagged crabs die as a result of the tagging operation and the proportion of tagged crabs which lose their tags in the interval between tagging and time of molting. This knowledge is necessary for precise determination of the natural death rate of crabs, proportion of the population taken by the fishery, and the fraction of the stock which survives to the next year. We estimated that approximately 2,000 male crabs must be tagged in this experiment in order to assure significant return, but we were able to tag only 350. It is apparent that this experiment will require considerably more vessel time than we are presently able to allocate in view of the demands of other research problems.

Two Russian king crab mothership operations were observed northwest of Amak Island. This area is somewhat farther west than commercial operations have been observed in the past and is usually an area of concentration for recently molted crabs that have been found to contain less meat than old-shelled crabs. However, the 1961 samples showed a slightly higher proportion of old-shelled crabs in this area than in past years.

During 1961, we received tags from 539 crabs recovered by fishing operations in the eastern Bering Sea during 1960 and 1961. In August, 415 king crab tags recovered aboard the mothership *Tokei-maru* were returned to us from Japan. Tags from two king crabs recovered by a United States fishing vessel in 1960 near Unalaska Island were returned in June. In February, 122 tags were returned from king crabs recovered by the Russian mothership, *Vsevolod Sibertsev* during 1960 operations. Table 17 gives a summary of our king crab releases and returns to date.

In addition to returns noted in Table 17, we are quite certain that recoveries have been made by the *Shinyo-maru* operations in 1960 and 1961. These recoveries have not as yet been transmitted to us. Russian recoveries for 1961 have not yet been received. Further, tagged king crabs must have been taken by

Table 17. Summary of tag releases and returns*.

Tagging year	Number tagged	Returns during 1954	1955	1956	1957	1958	1959	1960	1961	Total
1954	1,107	44	60	1	2	1	0	0	0	108
1955	1,351		32	53	35	18	12	6	2	158
1956	4,063			53	197	114	67	49	37	517
1957	13,795				39	192	235	182	151	799
1958	9,851					40	118	123	120	401
1959	4,447						41	77	81	199
1960	1,327								24	24
1961	2,790									
Total		44	92	107	273	365	473	437	415	2,206

* The table is presented to show the magnitude of release and returns. Since each year's tagging experiment varied in sex, size, and area, and the recovery is the result of varying fishing intensity, the data are not strictly comparable.

Japanese and Russian groundfish fleets in the past several years but these have not yet been returned. Requests for the tags and recovery information have been made to the government agencies.

One of our studies utilizing data from king crab tag returns is that of the growth of adult male king crabs. At present the report is in the hands of the printers and is expected to be published in the near future. The completion of this phase of our work is a notable step since the yield of a stock is dependent upon growth.

The relationship of meat content to size and molting stage is closely related to the study of crab growth. This project was emphasized during the 1961 vessel charter period, and a large number of field observations was collected to fill in gaps and to extend the range of data from previous years.

A report on the movements of crabs as determined from tag releases and recoveries is being prepared for publication. A description of the methods employed in this study and a general summary of the results appeared in the Annual Report for 1960.

A major objective of our investigations is to determine the distribution of the king crab population in the eastern Bering Sea, to estimate crab abundance, and to arrive at some judgment as to the accuracy of our abundance estimate. Because of the problems of sampling, it has long been apparent that it was not feasible to attempt to assess the entire king crab population which consists of countless millions of planktonic individuals as well as the more finite numbers of older crabs. We must, therefore, define

Table 18. Eastern Bering Sea king crab abundance estimates 1957–1960. (Survey totals only, no additions from commercial catch prior to survey or other adjustment of survey totals.)

Year of survey	Date	Number of males: Length (mm.)	New and soft shell	Old and very old	Total	Number of females
1957	June 25–July 25	<132.5	19,105,000	6,336,000	25,441,000	
		>132.5	5,375,000	7,782,000	13,157,000	
		Total	24,480,000	14,118,000	38,598,000	35,081,000
1958 (1)	April 29–June 3	<132.5	15,049,000	1,191,000	16,240,000	
		>132.5	15,462,000	6,767,000	22,229,000	
		Total	30,511,000	7,958,000	38,469,000	20,908,000
1958 (2)	June 8–July 11	<132.5	20,685,000	1,384,000	22,069,000	
		>132.5	10,646,000	6,790,000	17,436,000	
		Total	31,331,000	8,174,000	39,505,000	43,987,000
1959	May 2–19	<132.5	10,544,000	341,000	10,885,000	
		>132.5	18,184,000	6,961,000	25,145,000	
		Total	28,728,000	7,302,000	36,030,000	20,284,000
1960	August 2–30	<132.5	7,999,000	750,000	8,749,000	
		>132.5	3,170,000	5,775,000	8,945,000	
		Total	11,169,000	6,525,000	17,694,000	18,439,480

the population with which we are dealing as the adult crabs of the eastern Bering Sea which are accessible by otter trawl at the time of sampling. Our sampling has been restricted primarily to the broad shelf which is the locality of commercial crabbing operations. Because of migrations and other movements, the composition of the crab population on this shelf appears to be quite variable so that the results of sampling, both with regard to distribution and abundance, should be considered relative to the time of year when samples were taken. The effects of the removal of large numbers of crabs by the fishery prior to the time of the sampling must also be considered in comparing one year with another.

Abundance estimates for each station pattern survey were made by expanding the catch at each station in relation to the area of ocean bottom swept by the otter trawl. In 1958 two surveys were made; in 1957, 1959, and 1960 only one. Abundance estimates based on these surveys are given in Table 18.

In Figure 36 the abundance estimates for various groups of crabs have been arranged in time sequence by the midpoint of the survey period. This arrangement suggests that for females and new-shelled males a large part of the variation between years may be due to seasonal movement into and out of the sampling area rather than to actual differences in abundance in the eastern Bering Sea. However, for the large old-shell males the number in the sampling area appears to be relatively constant during the season of sampling, suggesting that there may be no significant migration of these crabs during the late spring and summer months. This is of particular significance since these large old-shell males are the crabs generally selected by the fisheries.

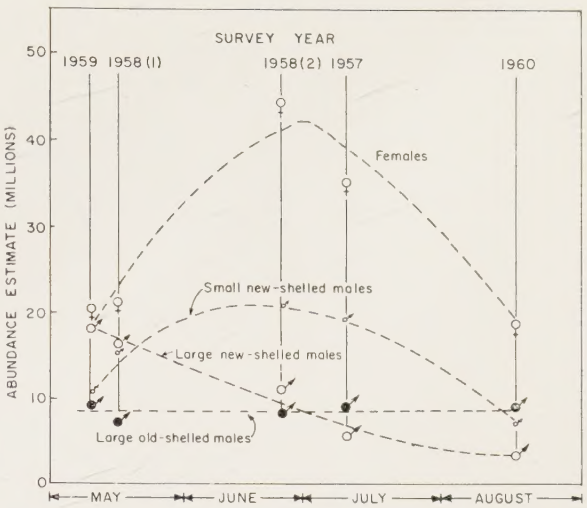

FIGURE 36. Bering Sea king crab abundance estimates, 1957–1960. (Large old-shelled estimates have been adjusted to compensate for commercial catches prior to the survey and for incomplete coverage of the station pattern in 1959.)

We have begun to make estimates of the level of yield which may be taken on a sustained basis from the eastern Bering Sea king crab stock. We believe that our present knowledge of the fishery and the population upon which it is based is sufficient for such calculations to be made. However, most of the factors which enter into yield calculations were determined for a period when the level of fishing was much less than we are experiencing at present.

Since it is probable that some of these factors may change as a result of the large increase in fishing during recent years, continued observations of the effects of the fishery upon the stocks are necessary.

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